

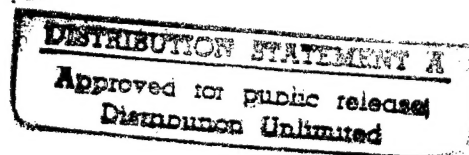
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# USSR Report

PHYSICS AND MATHEMATICS



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# USSR REPORT

## PHYSICS AND MATHEMATICS

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HIGH-FREQUENCY ASYMPTOTIC BEHAVIOR OF REFLECTED AND TRANSMITTED WAVES  
DURING SCATTERING OF SOUND BY HOLLOW ELASTIC SPHERE FILLED WITH FLUID

Moscow PRIKLADNAYA MATEMATIKA I MEKhanika in Russian  
Vol 47, No 6, Nov-Dec 83 (manuscript received 29 July 82) pp 954-961

PODDUBNYAK, A. P., L'vov

[Abstract] The problem of sound scattering is solved for a hollow elastic sphere containing an acoustic fluid, of particular concern being the asymptotic behavior of reflected and transmitted waves on the high-frequency side of the spectrum. The analysis is based on Fourier transformation with respect to time and resolution into spherical harmonics. Expressing the Fourier transformation of pressure in the scattered waves written as the Sommerfeld-Watson integral of the complex angular momentum makes it possible to consider components of the echo signal due to reflection by the outside boundary of the sphere as well as those due to re-reflection by its inside boundary. Using the ratio of inside radius to outside radius as a parameter of the problem, the latter is solved generally as well as for the extreme cases of a solid elastic sphere and a liquid sphere. The two reflection coefficients and the transmission coefficient are evaluated by application of the theory of graphs to the paths of longitudinal and transverse modes, in a way that relates mathematical quantities to physical concepts. The Sommerfeld-Watson integral is evaluated by the method of steepest descent, and the frequency characteristics of echo waves and pulses are calculated in terms of higher-order harmonics and short transients. The author thanks Ya. S. Podstrigach and N. D. Veksler for discussion of the results. Figures 4, references 15: 8 Russian, 7 Western.  
[175-2415]

ACOUSTIC PERTURBATIONS UNDER VARIOUS PULSED MELTING MODES

Moscow KRATKIYE SOOBSHCHENIYA PO FIZIKE in Russian  
No 10, Oct 83 (manuscript received 10 May 83) pp 48-52

SAMOKHIN, A. A.

[Abstract] This study investigates the influence of various pulsed melting modes on the acoustic perturbations which are excited in a condensed medium due to variations in density during heating and melting. The findings demonstrate a strong relationship between acoustic perturbations in the medium and the melting mode, which can be employed in experimental investigations of pulsed melting dynamics. References 5 Russian.  
[171-6900]

POLARIZATION-OPTICAL RECORDING OF ACOUSTIC WAVE GENERATED BY STRONG ELECTRON BEAMS IN SOLIDS (KCl)

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 12, Dec 83  
(manuscript received 7 Jan 83) pp 2417-2419

KULIKOV, V. D. and LISITSYN, V. M.

[Abstract] The spatial distribution of stresses in the region of an acoustic wave directly within the medium is investigated, employing phenomenon of induced birefringence for recording. Acoustic waves are excited in the specimen by a strong-current pulsed electron accelerator. The propagation velocity of the bipolar pulse in the specimen is estimated. The polarization-optical method can be used to investigate the form of the acoustic wave, which is determined by the value and spatial distribution of the energy introduced into the specimen. One advantage of the method is the possibility of obtaining information about the exact state of the acoustic pulse prior to the onset of propagation distortions. Figures 2, references 5 Russian.  
[152-6900]

## TRANSITIONAL ACOUSTIC EMISSION BY MIXING THERMAL OPTICAL SOURCE INTERSECTING MEDIA INTERFACE

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian  
Vol 47, No 10, Oct 83 pp 1969-1970

BUNKIN, F. V., KOLOMENSKIY, A. A., MALYAROVSKIY, A. I., MIKHALEVICH, V. G.  
and RODIN, A. M.

[Abstract] This study investigates transitional acoustic emission at the boundary of two liquids with different acoustic and thermophysical properties with allowance for variation in the intensity of laser radiation on the interface. The basic properties of transitional acoustic emissions by a moving longitudinal thermo-optical source are demonstrated, and the theoretical model employed is demonstrated to be valid. Figures 2, references 4 Russian.

[162-6900]

## SPIN SYSTEM RESONANT LINE SHIFT IN NARROW-BAND NOISE FIELDS

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI  
in Russian Vol 39, No 2, 25 Jan 84 (manuscript received 1 Dec 83) pp 56-58

NOVIKOV, D. N., Ural Polytechnical Institute imeni S. M. Kirov

[Abstract] Previous research has demonstrated paramagnetic resonance line shift under the action of a narrow-band noise field, and also dependence of the shift on power and width of the spectral line of the noise field. An analogous experiment is reported in this article. The study object was an assemblage of  $^{133}\text{Cs}$  atoms with electron paramagnetism under conditions of transverse optical pumping by circularly polarized resonant light. Small-signal rf probe radiation was linearly polarized and parallel to a constant magnetic field, enabling optical recording of paramagnetic resonance in the system of atoms. The experiment was shielded from magnetic interference. An investigation is made of the change in absorption spectrum of weak radiation under the effect of a gaussian narrow-band rf field formed from white noise by squaring filters. The results do not agree with those cited in earlier research. Figures 2, references 4 Russian.

[125-6610]

## COLLAPSE OF CAVITATION BUBBLES BETWEEN TWO WALLS IN ULTRASONIC FIELD

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 29, No 6, Nov-Dec 83  
(manuscript received 8 Jun 82) pp 754-757

DEZHKUNOV, N. V., KUVSHINOV, G. I., PROKHORENKO, P. P.,  
Institute of Applied Physics, BSSR Academy of Sciences

[Abstract] An investigation is made of the collapse of cavitation bubbles in the gap between two solid bounding surfaces based on high-speed motion picture photography. A streak camera was used to photograph light transmitted through a microscope. Exposure was frame-by-frame at a speed of  $6.25 \cdot 10^5$  frames per second. Ultrasonic vibration was at 21.7 kHz in ordinary tap water. The solid bounding surfaces were the radiating surface of a waveguide concentrator, the polished end face of a steel cylinder, and glass plates. The experimental results and theoretical analysis show that depending on the size of the gap, the bubbles collapse with the formation of liquid microjets directed either parallel (annular jets) or perpendicular (cumulative jets) to the bounding solid surfaces. This conclusion should be taken into consideration in practice when implementing processes of ultrasonic technology involving the force action that collapse of cavitation bubbles in a gap has on solid bounding surfaces. Figures 3, references 12: 9 Russian, 3 Western.  
[126-6610]

UDC 537.874.1

## METHOD OF SYNTHESIZING INTERFERENCE-IMMUNE ANTENNAS

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 29, No 6, Nov-Dec 83  
(manuscript received 14 Jan 81, after revision 14 May 82) pp 769-773

KARNOVSKIY, M. I., PUGACH, V. P. and TOROPOV, A. I., Kiev Polytechnical  
Institute imeni the Fiftieth Anniversary of the Great October Socialist  
Revolution

[Abstract] Various methods of synthesizing antennas for a given radiation pattern in the far field have been described in the literature. In this paper, the authors suggest a new approach giving a certain degree of precision in reproducing the assigned far-field radiation pattern, while at the same time providing a measure of immunity to near-field interference. In essence, the method involves finding a compromise sensitivity distribution for the antenna components such that the radiation pattern is an acceptable approximation of an assigned function, while the near-field interference is simultaneously minimized. By way of illustration, the authors give the results of synthesis of a rectilinear equidistant

quarter-wave eleven-element antenna, showing that the technique is suitable for designing antennas with moderate supergain in the presence of near-field interference. Figures 2, tables 2, references 12: 11 Russian, 1 Western.  
[126-6610]

UDC 517.9

DIFFRACTION OF ACOUSTIC WAVES BY ABSOLUTELY RIGID CYLINDER SURROUNDED BY LAYER OF INHOMOGENEOUS FLUID

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 29, No 6, Nov-Dec 83  
(manuscript received 9 Apr 82) pp 824-830

YAKOVLEV, V. V., Institute of Hydromechanics, UkSSR Academy of Sciences

[Abstract] The method of generalized power series is applied to the steady-state problem of diffraction of a planar acoustic pressure wave by an absolutely rigid cylinder of fixed radius surrounded by a layer of radially inhomogeneous compressible fluid. An investigation is made of the influence that the inhomogeneous layer has on scattering patterns and distribution of overall pressure on the surface of the cylinder. Figures 4, references 5 Russian.  
[126-6610]

UDC 621.315.592.2:546.68

NONLINEAR ABSORPTION OF LASER RADIATION IN InP AND IN GaAs

Vilnius LITOVSKIY FIZICHESKIY SBORNIK in Russian Vol 34, No. 5, Sep-Oct 83  
(manuscript received 15 Jun 82) pp 92-96

BENDORYUS, R. A., Vilnius Institute of Structural Engineering and  
MALDUTIS, E. K., Institute of Physics, LiSSR Academy of Sciences

[Abstract] Nonlinear absorption of light in semiconductor materials with wide forbidden band is an important factor determining the feasibility of light-emitting semiconductor devices based on two-photon excitation. From this standpoint, an experimental study was made of nonlinear absorption in weakly laser-irradiated InP and GaAs. The specimens for this study were mechanically polished plane-parallel n-InP and n-GaAs crystal plates with concentrations of free charges  $n = (2-4) \cdot 10^{16} \text{ cm}^{-3}$  and  $5 \cdot 10^{14} \text{ cm}^{-3}$  respectively. The light source was a YAG:Nd<sup>3+</sup> laser with Q-switching that emitted pulses of 30 ns duration and up to 4 mJ energy. A converging lens focused the incident laser beam on a crystal specimen, forming on its surface a light spot with an area of 0.05-5 mm<sup>2</sup>. Radiation transmitted by the crystal was, after passage through another converging lens, measured either with a calorimeter and a thermocouple-nanovoltammeter set or with a calorimeter with a milliwattmeter. An evaluation of the results, with interpretation based on theoretical relations for optical density and depthwise distribution of photon density, reveal that the former increases linearly in GaAs and not quite linearly in InP with increasing excitation intensity while the reflection coefficient remains constant. There is also a linear relation between the reciprocal of transmitted photon density and the reciprocal of incident photon density. With the light intensity decreasing with increasing penetration depth, there appears a linear component of absorption characteristic of one-photon absorption as well as a nonlinear component. The latter is evidently attributable to other mechanisms, the most likely one being two-photon absorption with attendant absorption by free charge carriers or through impurity levels of various depths. The control data on absorption in GaAs provide a statistical data base and a reference for monitoring such experiments. The authors thank Professor Yu. Vaytkus and Docent R. Baltrameyunas for constructive criticism. Figures 3, references 11: 4 Russian, 7 Western.  
[218-2415]

PHOTOCURRENT OSCILLATIONS IN  $\text{Bi}_{12}\text{GeO}_{20}$  METAL-SEMICONDUCTOR-METAL STRUCTURES

Tomsk IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: FIZIKA in Russian Vol 26,  
No 12, Dec 83 (manuscript received after revision 5 Mar 83) pp 101-102

ZAKHAROV, I. S. and PETUKHOV, P. A., Tomsk Institute of Automated Control  
Systems and Radioelectronics

[Abstract] Metal-semiconductor-metal [MSM] photosensitive structures have performance characteristics that are governed by the transient processes taking place in them when an external voltage is applied and they are exposed to light of various spectral compositions. When subjected to a short light pulse in the region of the natural absorption of the structure, it operates in a space charge limited mode and the transient process is determined by the transit of the charge carriers through the crystal. The transit time is inversely proportional to the voltage and falls in a range of tens of microseconds for typical working voltages of 300 to 500 V in bismuth sillenite chips. This paper studies the behavior of the transient photocurrent in  $\text{Bi}_{12}\text{GeO}_{20}$  MSM structures with chip thicknesses of 200 to 500 micrometers at working voltages of 60 - 800 V exposed to light at 400 to 600 nm. The structures were illuminated parallel to the electric field through a transparent cathode and in the end face on the shear of the crystal perpendicular to the electric field. Oscilloscope traces of the transient photocurrent for a sample 200 micrometers thick reveal three stages of the process when the voltage of light intensity is increased. The first phase is an initial jump in the photocurrent when the illumination is applied; the second phase shows the photocurrent falling off with time and corresponds to the accumulation of a positive charge in the chip due to the blocking properties of the contact that limit the transport of carriers from the metal into the semiconductor. The electric field intensity at the cathode rises in this case, while it falls off in the remaining volume, producing a drop in the photocurrent. In the third phase, the photocurrent is governed by the charge carrier relaxation processes at defects. The conductivity of the sample increases with time up to a steady-state level corresponding to the applied voltage. Photographs of the relevant oscilloscope traces are shown. In samples less than 500 micrometers thick, illuminated at a wavelength close to the edge of the intrinsic absorption band (about 400 nm), decaying photocurrent oscillations were observed; the period of the oscillations increased with time. The transient photocurrent, when a step voltage is applied, indicates strong polarization of the crystal and the occurrence of a considerable internal field due to the charge accumulated in the body of the crystal and then redistributed during the voltage pause. The application of a sine wave voltage produces a pronounced resonance in the photocurrent oscillations, depending on the applied frequency. The nonmathematical discussion indicates no applications, designs or descriptive equations. Figures 2, references 5: 4 Russian, 1 Western. [149-8225]

# INFLUENCE OF IONIZING RADIATION ON SPECTRA OF SURFACE-BARRIER ELECTRO-REFLECTANCE SPECTRA OF $\text{Al}_x\text{Ga}_{1-x}\text{As}$

Moscow POVERKHNOST': FIZIKA, KHIMIYA, MEKHANIKA in Russian  
No 12, Dec 83 pp 93-94

TKHORIK, Yu. A., KONAKOVA, R. V., YEVSTIGNEYEV, A. M., KRASIKO, A. N.,  
KORDOSH, P., MORVITS, M. and CHERVENAK, Ya.

[Abstract] This study employs the electro-reflectance method to investigate the influence of ionizing radiation on the parameters of epitaxial layers of solid solutions of  $\text{Al}_x\text{Ga}_{1-x}\text{As}$ . Electro-reflectance spectra were measured for  $h\nu = 1.3\text{--}1.9$  eV and  $T = 300$  K on Schottky barriers created by sputtering a semitransparent layer of chromium on the surface of  $\text{Al}_x\text{Ga}_{1-x}\text{As}$ . The free electron concentration in the  $\text{Al}_x\text{Ga}_{1-x}\text{As}$  was ( $n = 4 \cdot 10^{16} \text{ cm}^{-3}$ , with a thickness of  $5 \mu\text{m}$ . The electro-reflectance was analyzed quantitatively by measuring the capacitance-voltage characteristic and then computing the electric field strength near the surface. Ordinary degradation of the properties of the metal-semiconductor interface was observed when the specimens were irradiated with fast electrons at doses exceeding  $6 \cdot 10^{12} \text{ cm}^{-2}$ , and with  $^{60}\text{Co}$  gamma-quanta in doses exceeding  $3 \cdot 10^8 \text{ R}$ . References 4: 2 Russian, 2 Western.  
[150-6900]

# PHOTOLUMINESCENCE SPECTRA OF ION-BOMBARDED $\text{GeS}_x\text{Se}_{1-x}$ CRYSTALS

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 29, No 6, Dec 83  
(manuscript received 6 Feb 82) pp 1010-1012

DRAZHAN, A. V., ZUYEV, V. A. and KORBUTYAK, D. V.

[Abstract] Luminescence spectra of laminate  $\text{GeS}_x\text{Se}_{1-x}$  crystals and first data on the effect of bombardment by low-energy ions are reported, measurements having been made on crystals produced by static sublimation of p-GeS and p-GeSe compounds and subsequent pulling of their solid solutions from the gaseous phase. Test specimens were bombarded with  $\leq 1$  keV argon ions in doses from  $10^{13}$  to  $10^{19} \text{ cm}^{-2}$  to an implantation depth of 20 nm, control specimens were left unbombarded. Photoluminescence measurements were made at temperatures from 4.2 to 40 K, using an LG-38 CW He-Ne laser ( $\lambda = 632.8 \text{ nm}$ ) and an MDR-2 monochromator with an FEU-62 recording photomultiplier. An analysis of the dynamic characteristics reveals  $\text{LO}_2$ -phonons with energy that decreases smoothly upon transition from GeS to GeSe (Se atoms being heavier than S atoms). The results indicate that ion bombardment appreciably attenuates the original spectral lines, owing to nonradiative losses at the surface, and produces new lines



on the longwave side. This shift of the spectrum is attributable to selective dislodgment of sulfur from the solid solutions during ion bombardment. The changing of the gap width between energy bands in the process confirms this hypothesis. Typically, an ion bombardment dose of  $10^{14}$  cm<sup>-2</sup> effectively reduces  $x$  from 0.8 to 0.73 and from 0.5 to 0.45. Figures 1, references 2 Russian.  
[159-2415]

UDC 532.78

CALCULATING COMPOSITION DISTRIBUTION OF QUASIBINARY SOLID SOLUTIONS OF SEMI-CONDUCTOR COMPOUNDS OBTAINED VIA NON-ISOTHERMIC CRYSTALLIZATION

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 12, Dec 83  
(manuscript received 20 Jul 82 revised 16 Apr 83) pp 2400-2402

GRECHANNYY, O. A. and MAMULA, A. I.

[Abstract] A method is proposed that simplifies the numerical realization of the thermodynamic method of making the title calculations. The proposed method employs the concept of chemical affinity and extends the Prigozhin-Defey method to three-component two-phase systems including a quasibinary solid solution of congruently fusing chemical compounds with a negligibly small homogeneous region. The calculations consist of solving the Cauchy problem for a closed system of first-order differential equations describing displacement of compositions of solid and liquid phases along the line of equilibrium as temperature varies. Figure 1, references 11: 7 Russian, 4 Western.  
[152-6900]

NONLINEAR ACTIVE MATERIAL  $(La_{1-x}Nd_x)_3Ga_5SiO_{14}$

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian  
Vol 47, No 10, Oct 83 pp 1903-1909

KAMINSKIY, A. A., MILL', B. V., SIL'VESTROVA, I. M. and KHODZHABAGYAN, G. G.

[Abstract] The acoustics and electromechanical characteristics, as well as spectroscopic and lasing properties, of  $La_3Ga_5SiO_{14}^{3+}$  and  $Nd_3Ga_5SiO_{14}$  laser crystals are studied with respect to luminescent spectra, piezoelectric and dielectric constants, spectral-lasing characteristics, position of "Star" level, velocities of longitudinal and transverse acoustic waves and hypersound attenuation. Figures 4, references 8: 6 Russian, 2 Western.  
[162-6900]

POSSIBILITY OF GENERATING  $\gamma$ -RADIATION IN THIN LAYERS OF SINGLE CRYSTALS

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian  
Vol 47, No 10, Oct 83 pp 1898-1902

ANDREYEV, A. V., AKHMANOV, S. A. and KOV'YEV, E. K.

[Abstract] This study discusses new possibilities of generating coherent Mössbauer radiation associated with rapid recrystallization of active semi-conducting media that are amorphized by laser heating, as well as the possibility of developing waveguide structures in the x-ray band. Fast laser heating makes it possible to provide intense excitation of isomer levels with relatively short lifetimes while retaining the crystal lattice. The possibility of exciting waveguide x-ray modes in crystal films occurring on the surface during laser heating makes it possible to amplify mode discrimination and to increase the interaction time between the radiation and the active nuclei, leading to increased gain. Laser heating creates optimal geometry of the active region, obviating the acicular crystal shape that had earlier been considered optimal. Figures 2, references 10, 8 Russian, 2 Western.  
[162-6900]

## CAPACITIVE REACTANCE OF COMPENSATED SEMICONDUCTORS WITH DEEP CENTERS UNDER CONDITIONS OF TRANSMISSION OF EXCLUSION AND DOUBLE INJECTION CURRENTS

Tashkent IZVESTIYA AKADEMII NAUK UzSSR: SERIYA FIZIKO-MATEMATICHESKIKH NAUK in Russian No 6, Nov-Dec 83 (manuscript received 29 Jun 83) pp 32-36

ARONOV, D. A. and MAMATKULOV, B. R., Physicotechnical Institute imeni S. V. Starodubtsev, UzSSR Academy of Sciences, Tashkent "Order of the Red Banner of Labor" State University imeni V. I. Lenin

[Abstract] The carrier exclusion effect and the flow of double injection currents in "pure" and compensated semiconductors with deep centers take place under conditions of charge quasineutrality where the local change caused by these effects with electric field strength coordinate  $E$  is small compared with the space charge density of the excluded or injected nonequilibrium carriers. Since the conductivity modulation caused by these effects covers a considerable part of the crystal with dimensions reaching several hundred micrometers, and increases with increasing applied voltage  $V$ , the integral charge that is set up may be quite large, resulting in appreciable capacitance. For the exclusion effect, the authors call this the exclusion capacitance, and for the flow of

double injection currents, it is called exclusion-injection capacitance. This article gives the results of theoretical studies of the above-mentioned integral charge and the corresponding capacitance of a structure as a function of current or voltage, and the characteristic times of relaxation for the two effects. References 5 Russian.  
[112-6610]

UDC 621.315.592

NEGATIVE DIFFERENTIAL CONDUCTIVITY IN n-GaAs ON TRANSIT-RESONANCE FREQUENCIES

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 17, No 12, Dec 83

STARIKOV, Ye. V. and SHIKTOROV, P. N., Institute of Physics of Semiconductors, LiSSR Academy of Sciences, Vilnyus

[Abstract] The paper gives the results of Monte Carlo determination of drift velocity of electrons in n-GaAs in an alternating electric field with consideration of the actual times of interaction of electrons with optical and acoustic phonons and ionized dopant. It is shown that in the vicinity of resonant frequencies, there is a region of negative differential conductivity. In the absence of scattering by ionized impurities, negative differential conductivity arises on frequencies somewhat higher than the transit-resonance frequency. Analysis of the conditions of occurrence of negative differential conductivity on transit resonance in n-GaAs in the absence of a magnetic field shows that in sufficiently pure specimens of n-GaAs with ionized dopant concentration of less than  $10^{15} \text{ cm}^{-3}$ , and in similar materials such as indium phosphide, negative differential conductivity can be expected to occur up to lattice temperatures of about 50 K. The phenomenon will be observed at a maximum frequency of about  $(1.5-1.9) \cdot 10^{12} \text{ Hz}$ . Figures 2, references 7 Russian.  
[127-6610]

MAGNETOABSORPTION OF WEAK LIGHT WAVE IN PRESENCE OF INTENSE LIGHT WAVE  
IN SEMICONDUCTOR WITH NARROW FORBIDDEN BAND

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 17, No 12, Dec 83  
(manuscript received 12 May 83) pp 2163-2167

MONOZON, B. S. and ZHILICH, A. G., Leningrad State University imeni  
A. A. Zhdanov

[Abstract] A theoretical analysis is made of interband magnetoabsorption of a weak light wave on frequency  $\omega'$  in the presence of a strong light wave with frequency  $\omega$  in a semiconductor with narrow forbidden band. Both waves are identically polarized parallel to an external constant magnetic field. An analytical expression is derived for the probability of absorption of a single photon of the weak wave in transition between quasi-energy states of the conduction and valence bands that are formed by a large number of photons of the strong wave. The probabilities of a single-photon transition are different in the case of an odd or even total number of photons. The ratio between them is determined by the ratio of the distance between Landau levels, which is proportional to the magnetic field, and by the width of the forbidden band. It is shown that in a sufficiently strong magnetic field where the distance between Landau levels becomes commensurate with the width of the forbidden band, maxima in magnetoabsorption of a weak wave arise in a narrow-band semiconductor in contrast to the case of crystals with a wide forbidden band, regardless of the evenness or oddness of the total number of photons that take part in the transition. References 11: 9 Russian, 2 Western.  
[127-6610]

EFFECTIVE TRANSFER OF EXCITATION FROM EMITTER TO ACTIVE REGION IN PHOTO-  
LUMINESCENCE OF InGaAsP/InP DOUBLE HETEROSTRUCTURE

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 17, No 12, Dec 83  
(manuscript received 19 Jul 83) pp 2168-2172

GARBUZOV, D. Z., AGAFONOV, V. G., AGAYEV, V. V., LANTRATOV, V. M. and  
CHUDINOV, A. V., Physicotechnical Institute imeni A. F. Ioffe, USSR Academy  
of Sciences, Leningrad

[Abstract] An investigation is made of the way that intensity of radiation of the active region of an InGaAsP/InP double heterostructure depends on the energy of stimulating photons in the 1.08-3.68 eV range for different thicknesses of the irradiated InP emitter. The study specimens were made from undoped isotype N-n-N double heterostructures grown by liquid

epitaxy on n-InP [100] substrates. The concentration of uncontrolled donors in the active  $\text{In}_{0.73}\text{Ga}_{0.27}\text{As}_{0.6}\text{P}_{0.4}$  region ( $\lambda = 1.3 \mu\text{m}$ ) and in the n-InP emitter was  $10^{17} - 2 \cdot 10^{17} \text{ cm}^{-3}$ . The thickness of the active region was about  $1 \mu\text{m}$ , and the thickness of the upper n-InP emitter ranged from  $0.9$  to  $6 \mu\text{m}$ . In some cases, specimens with differing emitter thickness were made from a structure with thick emitter by varying the time of etching in 1:1 hydrobromic acid and 10% potassium dichromate. Excitation was by a set of lasers over a range of  $5-500 \text{ W.cm}^2$ . Emission intensity was measured by a germanium photocell in tight contact with the n-InP substrate. It is shown that in the case of InGaAsP/InP double heterostructures, luminescence yield may remain almost unchanged over the entire range of energies of the stimulating quanta. This effect is due to the low rate of surface recombination on the external irradiated surface of the n-InP emitter. The results are compared with a simple theory that considers only diffusion of nonequilibrium charge carriers. Figures 3, references 12: 8 Russian, 4 Western. [127-6610]

UDC 621.315.592

# SCATTERING OF ELECTRONS ON PIEZOELECTRIC POTENTIAL OF OPTICAL PHONONS IN n-CdGeAs<sub>2</sub>

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 17, No 12, Dec 83  
(manuscript received 11 Apr 83) pp 2198-2201

BORISENKO, S. I., KARAVAYEV, G. F., SKACHKOV, S. I. and TYUTEREV, V. G.  
Siberian Physicochemical Institute imeni V. D. Kuznetsov affiliated  
with Timsk State University

[Abstract] An expression is derived for constants of piezoelectric potential of optical phonons, and an analysis is made of the mechanism of scattering on this potential in CdGeAs<sub>2</sub>. The frequencies of longwave phonons, oscillator strengths and constants of piezoelectric scattering are calculated for this chalcopyrite, and compared with experimentally measured values. It is found that nonpolar optical scattering can be disregarded in this semiconductor as compared with polar optical and acoustic vibrational scattering. The role of nonpolar optical branches are considerably separated in energy, and also in the case of carriers with large effective masses, such as holes. At low temperatures, scattering is predominantly on the charged impurity at ion concentrations of about  $10^{17} \text{ cm}^{-3}$ . At high temperatures, the principal mechanism is polar optical scattering. Contributions from all polar optical branches are of about the same order of magnitude. Figures 2, table 1, references 9: 3 Russian, 6 Western.

[127-6610]

## TWO-PHOTON INTERBAND TRANSITIONS OF ELECTRONS THROUGH DEEP IMPURITY LEVELS IN SEMICONDUCTORS WITH NARROW FORBIDDEN BAND

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 17, No 12, Dec 83  
(manuscript received 10 Jun 83) pp 2216-2218

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imeni A. V. Lunacharskiy

[Abstract] Two-photon transitions of electrons in the field of an intense electromagnetic wave from the valence band to the conduction band via intermediate impurity levels are analyzed in the Kane model. An investigation is made of spin orientation of carriers in the conduction band directly after transition in a field of circularly polarized emission. The ratio found for probabilities of two-photon transitions to the conduction band from the valence band with heavy and with light holes is lower than the value found by I. P. Areshev [FIZIKA I TEKHNIKA POLUPROVODNIKOV, Vol 11, 1977, p 962], indicating that the contribution of impurities to the probability of two-photon transitions must be taken into consideration when the concentration of impurities exceeds  $10^{16} \text{ cm}^{-3}$ . References 7: 5 Russian, 2 Western.  
[127-6610]

## MECHANISMS OF LASER ANNEALING OF SEMICONDUCTORS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 17, No 12, Dec 83  
(manuscript received 20 Jul 83) pp 2224-2228

ABAKUMOV, V. N., ALFEROV, Zh. I., KOVAL'CHUK, Yu. V. and PORTNOY, Ye. L.,  
Physicotechnical Institute imeni A. F. Ioffe, USSR Academy of Sciences,  
Leningrad

[Abstract] The authors consider the problem of laser annealing mechanisms, and analyze the results of previous research on the fluidity of semiconductor material exposed to millisecond and nanosecond pulses of laser radiation, as well as recent results of research on the action of picosecond light pulses. Both the thermal and plasma models of laser annealing are considered. It is found that experimental results are easily interpreted within the thermal model, and cannot be explained by the model of cold plasma annealing. It is concluded that there is no need to reject the model of thermal melting and recrystallization in pulsed laser action, even when the pulses are of picosecond duration. Under the action of ultrashort laser pulses, rapid nonequilibrium processes of a thermal type occur on the early stages of annealing, but then,

as nonequilibrium is resorbed, the energy of the absorbed pulse in the final analysis will be transferred to the lattice in the layer near the surface to a thickness of the order of 1  $\mu\text{m}$ , and melting will occur. If "softening" of valence bonds causes melting to begin at a temperature below the melting point, as the energy of photons advances into the lattice, the melt is heated to these temperatures, and the melting front advances to depths where normal melting would have begun initially. References 19: 13 Russian, 6 Western.  
[127-6610]

UDC 621.315.592

#### PHOTOLUMINESCENT PROPERTIES OF EPITAXIAL p-GaSb

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 17, No 12, Dec 83 (manuscript received 24 May 83) pp 2228-2230

ZIMOGOROVA, N. S., KANSKAYA, L. M., KRYACHKO, I. V., SAZONOV, V. A. and SHOSTKA, V. I., Physicotechnical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] The paper gives the results of studies of the photoluminescence properties of epitaxial layers of p-type gallium antimonide with and without acceptor dopants. Layers 5-20  $\mu\text{m}$  thick were grown on GaSb <111> substrates from a solution-melt of antimony and gallium to which zinc was added as an acceptor dopant. Luminescence of the specimens was stimulated at 77 and 4.2 K by the 1.15  $\mu\text{m}$  line of an LG-126 He-N<sub>2</sub> laser. Analysis of the spectra for undoped layers shows that the "background" level in the epitaxial material is reduced by a decline in the concentration of natural defects, showing up as a reduction in the intensity of longwave luminescence bands that predominate in the photoluminescence spectra of bulk specimens of undoped GaSb. Analysis of the spectra for the doped specimens shows that the activation energy is lower than predicted for a hydrogen-like acceptor, and also lower than cited in some previous research. At high concentrations of free carriers in doped specimens, narrowing of the forbidden band is observed and the Fermi level penetrates into the valence band. Emission intensity is reduced due to an increase in the role of Auger processes with times becoming decisive in the mechanism of recombination upon attainment of high doping levels in gallium antimonide. Figures 2, references 10: 6 Russian, 4 Western.  
[127-6610]

# EVALUATING DEGREE OF ORDER OF SINGLE CRYSTAL SURFACE FROM DISAPPEARANCE-POTENTIAL SPECTRA OF ELASTICALLY REFLECTED ELECTRONS

Moscow POVERKHNOST': FIZIKA, KHIMIYA, MEKHANIKA in Russian No 2, Feb 84  
(manuscript received 1 Feb 83) pp 71-73

BONDARCHUK, A. B., GOYSA, S. N., KOVAL', I. F., MEL'NIK, P. V. and  
NAKHODKIN, N. G., Kiev State University

[Abstract] The paper gives examples of estimates of the degree of disordering of the surface of GaP(111)B under the action of ion (Ar<sup>+</sup>) and electron beams as determined from the change in intensity of diffraction features. The measurements were done in an ultrahigh-vacuum electron spectrometer with three-grid decelerating analyzer. The results show that observation of diffraction singularities in the disappearance-potential spectrum of elastically scattered electrons provides supplementary information on the degree of order, and localization of disordered regions in layers of very small thicknesses using the same instruments that are intended for Auger and positional spectroscopy. Figures 3, references 2:  
1 Russian, 1 Western.  
[113-6610]

# SLOW MAGNETOPLASMA WAVES ON SURFACE OF MAGNETIZED SEMICONDUCTOR: WAVEGUIDE PROPAGATION

Moscow POVERKHNOST': FIZIKA, KHIMIYA, MEKHANIKA in Russian No. 2, Feb 84  
(manuscript received 5 Jan 83, after revision 4 Mar 83) pp 100-103

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[Abstract] An investigation is made of the influence that a change in orientation of the external magnetic field has on propagation of waveguide modes of magnetoplasma waves. Measurements were done on a frequency of 50 MHz at room temperature on a plane-parallel 15 x 15 mm indium antimonide plate 3.5 mm thick. The specimen was placed between the poles of an electromagnet, and the rf signal transmitted over the surface in waveguide propagation was recorded. Preferred directions of magnetization and nonreciprocity are observed due to formation of waveguide modes of a slow surface magnetoplasma wave and helicons. Figures 3, references 5: 4 Russian, 1 Western.  
[113-6610]



# INCREASED ELECTRICAL CONDUCTIVITY OF SEMICONDUCTOR SURFACE LAYER AT LOW TEMPERATURES

Moscow POVERKHNOST': FIZIKA, KHIMIYA, MEKHANIKA in Russian No 2, Feb 84  
(manuscript received 1 Feb 83, after revision 25 Apr 83) pp 110-112

KARAPETYAN, S. S. and KOROSTELIN, Yu. I., All-Union Scientific Research  
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[Abstract] An investigation is made of the influence that contact interaction accompanying friction has on electrical conductivity of semiconductor surface layers. For a Ge-Ge friction couple in liquid helium, electrical resistance over a 1.5 hour period declined from  $10^7$  to  $10^4 \Omega$  with a simultaneous increase in the coefficient of friction from 0.12 to 0.17. For a Ge-Pb friction couple, electrical resistance decreased to  $10^{-3} \Omega$  after five hours. Lead particles were detected on the germanium surface by microspectral analysis. The temperature dependence of electrical resistance in the 4.2-30 K range is nonlinear with a pronounced peak in the vicinity of 10-12 K. Figures 2, references 3.  
[113-6610]

# EPR STUDY OF DEFECT FORMATION ON SILICON SURFACE EXPOSED TO LASER EMISSION

Moscow POVERKHNOST': FIZIKA, KHIMIYA, MEKHANIKA in Russian No 2, Feb 84  
(manuscript received 3 Feb 83, after revision 11 Apr 83) pp 113-115

KARYAGIN, S. N., KASHKAROV, P. K, KISELEV, V. F. and PETROV, A. V.,  
Physics Institute, Moscow State University imeni M. V. Lomonosov

[Abstract] It has been established in previous research that laser irradiation of semiconductor crystals generates defects near the surface that are fast states and recombination states. The nature of such defects cannot be studied by electrophysical methods. In this paper the authors use an EPR technique to get information on these defects. Two types of silicon specimens were studied: Si<sub>I</sub> heated at 1000 K and abruptly cooled with retention of a certain concentration of B spin centers, and Si<sub>II</sub> slowly cooled after annealing at 1000 K with no paramagnetic centers. Exposure was by a series of monopulses on the second harmonic of a neodymium laser on a wavelength of 0.53  $\mu\text{m}$  in Q-switched operation (pulse duration 15 ns). It was found that exposure to an intense light pulse causes deformation of the short-range coordination sphere of surface atoms with bond breaking. The EPR signal from such centers is characterized by a g-factor of 2.0043. The effect is explained on the basis of the Jahn-Teller effect. Figures 3, references 9:  
6 Russian, 3 Western.  
[113-6610]

# ORIENTATION AND SUBSTRUCTURE OF GOLD FILMS CONDENSED ON GaAs JUVENILE SURFACE

Moscow POVERKHNOST': FIZIKA, KHIMIYA, MEKHANIKA in Russian No 11, Nov 83  
(manuscript received 7 Sep 82) pp 45-49

IYEVLEV, V. M., IVANOV, V. I., AMMER, V. A., BUROVA, S. V. and VALYUKHOV, D. P., Voronezh Polytechnical Institute

[Abstract] The electron microscope is used to study the orientation and substructure of gold films condensed in vacuum on the juvenile (110) surface of GaAs crystals at substrate temperature of 300-360 K. The effect of the juvenile surface of a cleavage shows up in reduced temperature of the growth of single-crystal gold films. Single-crystal films on juvenile surfaces (110) grew in parallel orientation at a substrate temperature of 370 K, and on surfaces prepared by cleavage in air--at a substrate temperature of 470 K. Analysis of x-ray photoelectron spectra from the surface of GaAs plates with (001) orientation at different temperatures showed that the temperature dependence of oriented growth of gold films correlates with the way that the amount of oxide on the GaAs surface depends on treatment temperature. Figures 3, references 7 Russian.  
[130-6610]

# DETERMINING COMPOSITION IN SURFACE REGION OF SEMICONDUCTOR CRYSTALS BY METHOD OF SUDDEN CHANGES IN X-RAY PHOTOELECTRIC EFFECT

Moscow POVERKHNOST': FIZIKA, KHIMIYA, MEKHANIKA in Russian No 11, Nov 83  
(manuscript received 24 Nov 82) pp 56-61)

SHCHEMELEV, V. N., TAGIROV, I. R., BUABELLU, A. and SOZONTOV, Ye. A., Leningrad State University imeni A. A. Zhdanov

[Abstract] The composition of material in the region near the surface of semiconductor solid solutions is studied by a method of sudden changes in the spectral dependence of the x-ray photoelectric effect on the absorption edges of the elemental components of the semiconductor material. The theory of the method is given. X-ray photoelectric jumps are measured in germanium, gallium arsenide, and solid solutions of  $\text{In}_x\text{Ga}_{1-x}\text{As}$  with different InAs and GaAs concentrations. Calibration curves are plotted for the magnitude of shifts in the photoelectric effect as a function of concentration of the solution component. Comparison of experimental and theoretical results enables determination of the composition of a solid solution at depths of formation of the photoelectric effect. Figures 4, table 1, references 10: 8 Russian, 2 Western.  
[130-6610]

CALCULATION OF TEMPERATURE FIELD IN INHOMOGENEOUSLY DOPED SILICON  
WITH PULSED LASER ANNEALING

Moscow POVERKHNOST': FIZIKA, KHIMIYA, MEKHANIKA in Russian No 11, Nov 83  
(manuscript received 11 Aug 82) pp 138-146

KAPAYEV, V. V.

[Abstract] Temperature distribution in ion-doped silicon is determined on the basis of numerical solution of the nonlinear equation of heat conduction with consideration of melting of the surface layer of material as it absorbs pulsed laser emission. It is shown that integral characteristics of the process such as maximum thickness of the melt and maximum surface temperature are considerably dependent on the characteristic dimension of an inhomogeneity in the optical characteristics of the specimen due to ion implantation. A curve is plotted for the maximum thickness of the melt as a function of energy in the laser pulse. An examination is made of the case of simultaneous action of laser pulses with wavelengths of 1.06 and 0.53  $\mu\text{m}$ . It is shown that emission energy is utilized more efficiently when there is a delay in the pulse with longer wavelength. The optimum delay time is determined. Figures 5, references 15:  
7 Russian, 8 Western.  
[130-6610]

## INSTABILITY IN SEMICONDUCTORS EXPOSED TO IONIZING RADIATION

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 2,  
26 Jan 84 (manuscript received 1 Dec 83) pp 65-68

VERNER, I. V., MAKSIMOV, S. K. and TSUKANOV, V. V., Moscow Institute  
of Electronic Technology

[Abstract] An analysis is made of the possibility that exposure of semiconductors to ionizing radiation might give rise to unstable states with accumulation of point defects. It is shown that instabilities may arise in processes of generation of interstitial atoms and vacancies, formation and dissociation of complexes of vacancies with impurity atoms, annihilation of interstitial atoms with vacancies on centers that are formed, and also interaction of interstitial atoms and vacancies with dislocations and interfaces. The results show that the prevalent opinion that the defect profile corresponds to the depth distribution of energy expended on atomic collisions is not necessarily the only correct model. A detailed analysis should be made of secondary processes with consideration of the fact that irradiation of a semiconductor gives rise to time, space, and space-time dissipative structures. References 4: 3 Russian, 1 Western.  
[124-6610]

EFFECTS OF INTERACTION OF MAGNETOSTATIC AND ELASTIC WAVES IN STRUCTURES  
WITH TANGENTIALLY MAGNETIZED YIG FILM OF SUBMICRON THICKNESS

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 2,  
26 Jan 84 (manuscript received 5 Oct 83) pp 90-94

ANDREYEV, A. S., ZIL'BERMAN, P. Ye., KRAVCHENKO, V. B., OGRIN, Yu. F.,  
TEMIRYAEV, A. G. and FILIMONOVA, L. M., Institute of Radio Engineering  
and Electronics, USSR Academy of Sciences, Moscow

[Abstract] The article is a report on the first observations of resonant  
striction interaction of magnetostriction waves with elastic Lamb waves in  
structures that include a tangentially magnetized saturated YIG film of  
submicron thickness on a gadolinium-gallium garnet (GGG) substrate. An in-  
vestigation is made of the particulars of magnetostriction wave propagation  
in these structures that are due to magnetoelastic coupling. The input  
and output magnetostriction wave transducers were formed by aluminum  
microstrips. The structure was placed in a controllable tangential  
magnetic field. Measurements in the cw mode were done with a wobulator  
tunable over a 2-4 GHz range. Analysis of the amplitude frequency  
response shows resonances between the magnetostriction wave in the  
film and Lamb modes in the substrate with mode numbers of around 840.  
In experiments with a pulse-modulated microwave signal, it was found  
that magnetoelastic coupling results in considerable pulse delay times.  
Figures 2, references 3: 2 Russian, 1 Western.  
[124-6610]

PHOTOELECTRIC PROPERTIES OF ZnSe-GaAs HETEROJUNCTION

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 2,  
26 Jan 84 (manuscript received 11 Nov 83) pp 118-121

DEVYATYKH, G. G., ZHUK, B. V., ZLENKO, A. A., PROKHOROV, A. M., KHAMYLOV, V.K.  
and SHIPULO, G. P., Institute of General Physics, USSR Academy of Sciences,  
Moscow

[Abstract] The authors study the photoelectric properties of an  
n-ZnSe-p-GaAs heterojunction produced by the MOS-hybrid process at reduced  
pressure. The substrates were p-type gallium arsenide of orientation (100)  
with carrier concentration of  $10^{19}$ - $2 \cdot 10^{19}$  cm<sup>-3</sup>. Special steps were taken  
to prevent formation of a transition layer near the heteroboundary.  
The studies were done on ZnSe films 2  $\mu$ m thick doped with aluminum  
with donor concentration of  $(3-8) \cdot 10^{16}$  cm<sup>-3</sup> and resistivity of no more  
than 0.2  $\Omega$ -cm. Analysis of quantum yield as a function of wavelength  
shows that in the range of 460-890 nm, the coefficient of carrier collection  
is 0.92-1 with respect to the number of photons reaching the pn junction.  
The current-voltage characteristic of the heterojunction shows that  
tunneling is the predominant mechanism of current flow. Near the interface  
in the ZnSe is a layer 100-150 nm thick in which the carrier concentration

decreases as the interface is approached. Analysis of the load characteristics taken under direct solar radiation and with different degrees of concentration of solar radiation shows that the series resistance of the diode is 15-20  $\Omega$ . Efficiency ranges from 15 to 18%, depending on incident power. Calculations show that this figure could be raised to 22% by a reflection-reducing coating. Figures 2, references 9:

6 Russian, 3 Western.

[124-6610]

#### PHOTOELASTIC PROPERTIES OF BISMUTH GERMANATE

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 2, 26 Jan 84 (manuscript received 30 Sep 83) pp 124-126

KUCHA, V. V., MIRGORODSKIY, V. I., PESHIN, S. V. and SOBOLEV, A. T.

[Abstract] All components of the elasto-optic tensor of bismuth germanate ( $\text{Bi}_{12}\text{GeO}_{20}$ ) are measured on parallelepiped single crystals with dimensions of 20 x 30 x 10 mm having the sides oriented along crystallographic directions [001] within about  $0.5^\circ$ . Longitudinal and shear acoustic waves were excited by  $\text{LiNbO}_3$  piezoelectric transducers on about 150 MHz. Plane-polarized radiation was used in the measurements. The length of acousto-optic interaction was taken as less than 1 mm to reduce the effect that optical activity of the crystal has on the efficiency of such interaction. Analysis of results of measurement on a wavelength of 0.633  $\mu\text{m}$  shows that components  $P_{12}$  and  $P_{13}$  differ slightly from  $P_{11}$ , which means that the diffraction efficiency on the longitudinal wave is weakly dependent on the direction of the plane of polarization of light. It is also shown that rotating the plane of polarization of light through an angle of about  $22^\circ$  on the interaction length gives an error of no more than 5%. Table 1, references 8: 3 Russian, 1 Polish, 4 Western.

[124-6610]

#### FORMATION OF PERIODIC STRUCTURES ON SILICON SURFACE UNDER ACTION OF NEODYMIUM PULSE OF MILLIMETER DURATION

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 1, 12 Jan 84 (manuscript received 11 Nov 83) pp 15-20

VEYKO, V. P., DOROFYEV, I. A., IMAS, Ya. A., KALUGINA, T. I., LIBENSON, M. N. and SHANDYBINA, G. D.

[Abstract] The paper is a report on observation of the formation of periodic structures on the surface of silicon under the action of a neodymium laser pulse of millimeter duration that cannot be readily explained by

concepts of excitation of a surface wave and modulation of the temperature field on the surface in consequence of interference between the incident wave and the surface wave. The light source in the experiments was a quasi-cw laser with pulse duration of 4 ms. Emission was focused on the silicon surface in a spot measuring about 600  $\mu\text{m}$ . The dynamics of change in surface relief was studied by analyzing the scattered emission of a ruby probe laser with pulse spacing of 100-250  $\mu\text{s}$ . In contrast to structures formed by generation of surface electromagnetic waves, the observed structures had a period about triple the wavelength of the incident laser light. This period, as well as the orientation of the structures, was independent of the angle of incidence of the radiation, or its direction of polarization. However, it was found that the form of the structures and their orientation are determined by the orientation of the crystallographic axes on the surface of the specimen. The process of formation of the surface structure can be stopped at any stage by changing the density of the incident light flux. The height of the relief averaged about 600  $\text{\AA}$ , reaching 2000  $\text{\AA}$  at points of intersection of two gratings. Formation of the structures is accompanied by oxidation in air. It is suggested that the observed structure may be due to instability of the flat surface of the condensed phase that arises upon laser exposure. Figures 2, references 4: 3 Russian, 1 Western.  
[121-6610]

#### DYNAMICS OF GROWTH OF SURFACE PERIODIC STRUCTURES WHEN INTENSE LIGHT ACTS ON CONDENSED MEDIA

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 1, 12 Jan 84 (manuscript received 9 Nov 83) pp 3-8

BONCH-BRUYEVICH, A. M., LIBENSON, M. N. and MAKIN, V. S.

[Abstract] The authors consider the dynamics of formation of surface periodic structures that arise upon spatial modulated heating of a rough surface of a condensed medium in the interference field of a surface electromagnetic wave and the incident radiation producing it. Investigation of surface periodic structures has shown that there are several thermal mechanisms of variation of surface relief; sublimation, evaporative, hydrochemical and deformational. A common feature of all these mechanisms is a monotonic change in the local velocity of surface motion along the external normal to the unperturbed plane boundary over a wide temperature range. In many cases, this enables description of local relief distortions in an approximation that is linear with respect to quasisteady local temperature deviations. It is shown that conversion of incident radiation to surface electromagnetic waves is insufficient in and of itself to cause growth of surface periodic structures. There must also be a definite phase shift between the spatial distributions of the height of the cosinusoidal grating on the surface of the medium and the intensity

of the absorbed radiation. This shift is determined by the ratio of the imaginary and real components of the permittivity of the medium, and is retained in the distribution of the temperature field on the surface when the medium is heated by the resultant flux of the intensity distribution of absorbed radiation in the reference field, assuming that the energy coefficient of conversion is small for a given amplitude and space frequency near the resonant frequency of the surface TM polariton. If a major role in formation of the surface periodic structure is played by interference of components of the field that are parallel to the plane of the surface, the phase shift that arises when the absolute value of the real component of permittivity is much greater than the imaginary component gives weak positive feedback between the grating amplitude and the fraction of radiation converted to surface electromagnetic waves, leading to relatively slow growth of surface periodic structures. TE-polaritons may also be excited on a rough surface that by themselves cannot produce a distinguishable surface periodic structure. However, if some grating has already been produced by generation of TM-polaritons, its dynamics on later stages may be determined by conversion of the incident light to a TE surface electromagnetic wave for which the phase shift is close to the optimum of  $\pi$ . References 3: 1 Russian, 2 Western. [121-6610]

#### CASCADED SOLAR PHOTOVOLTAIC CELLS BASED ON InP-GaInPAs AND InP-CdS HETEROSTRUCTURES

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 1, 12 Jan 84 (manuscript received 15 Nov 83) pp 51-55

ALLAKHVERDIYEV, A. M., ANDREYEV, V. M., GUSEYNOV, I. A., IVENT'YEVA, O. O. and ISMAILOV, V. I., Physicotechnical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] The paper gives the results of studies of cascaded solar cells with different widths of the forbidden band: narrow-band (0.8-1.0 eV) and wide-band (1.6-1.8 eV). The narrow-band cell was based on nInP-n(p)GaInPAs-pInP heterostructure, and the wide-band cell was based on pInP-nCdS heterostructure with similar lattice parameters of the contacting materials. The narrow-band cells were made by liquid-phase epitaxy, and the wide-band cells were made by gas-transport precipitation of CdS. The spectral characteristics show the feasibility of expanding the region of photosensitivity by using the principle of cascaded conversion of solar energy. The cell with pn junction in  $\text{Ga}_{0.5}\text{In}_{0.75}\text{As}_{0.85}\text{P}_{0.42}$  utilizes light with photon energies of less than 1.35 eV that have passed without absorption through the covering photocell. The longwave limits of photosensitivity are determined by the width of the forbidden band of the active region of the corresponding photocells. The shortwave end of the spectrum is "stretched out" as a result of the low surface recombination rate. It should be possible to bring efficiency up to 30%

with more than 100-fold concentration of solar radiation in monolithic two-junction cascaded solar cells based on a system of Ga-In-As-P and InP-CdS. Figures 2, references 6: 5 Russian, 1 Western.  
[121-6610]

UDC 548.74

#### STRUCTURE OF AMORPHOUS $\text{As}_2\text{S}_3$ FILMS

Baku IZVESTIYA AKADEMII NAUK AZERBAYDZHANSKOY SSR: SERIYA FIZIKO-TEKHNICHESKIKH I MATEMATICHESKIKH NAUK in Russian Vol 4, No 2, Oct-Dec 83 (manuscript received 17 Jul 82) pp 75-77

EFENDIYEV, E. G. and SHAFIZADE, R. B., Institute of Physics, Azssr Academy of Sciences

[Abstract] The authors determine the parameters of short-range order in amorphous films of  $\text{As}_2\text{S}_3$  produced by thermal vaporization of the vitreous sulfide at  $250^\circ$  and  $50^\circ\text{A}/\text{min}$ . The films were grown to a thickness of  $300\text{ \AA}$ . Three haloes were observed, corresponding to effective interplanar distances of 2.93, 1.71 and  $1.14\text{ \AA}$ . Curves are plotted for the normal intensity of scattering of 75-keV electrons by the specimens, and for the radial distribution of atoms, from which the parameters of short-range order were calculated. The radius of the first coordination sphere is found to be  $2.22\text{ \AA}$ , corresponding to the As-S distance, and the radius of the second coordination sphere is  $3.5\text{ \AA}$ , corresponding to both the As-As and S-S distances. It is concluded that the scattering unit of  $\text{As}_2\text{S}_3$  is a tetrahedron with arsenic atoms at the vertices and a sulfur atom in the center. Figures 3, references 7: 5 Russian, 2 Western.  
[161-6610]

UDC 621.315.592

#### RECOMBINATION RADIATION OF p- $\text{CdSiAs}_2$ CRYSTALS GROWN WITHOUT DOPING

Ashkhabad IZVESTIYA AKADEMII NAUK TURKMENSKOY SSR: SERIYA FIZIKO-TEKHNICHESKIKH, KHIMICHESKIKH I GEOLOGICHESKIKH NAUK in Russian No 5, Sep-Oct 83 (manuscript received 13 Jan 82) pp 13-18

MAMEDOV, A. PARIMBEKOV, Z. A., RUD', Yu. V. and SERGINOV, M., Physico-technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Physico-technical Institute, TuSSR Academy of Sciences

[Abstract] The diarsenide of cadmium and silicon  $\text{CdSiAs}_2$  is the electronic analog of gallium arsenide. In this paper, a comprehensive study is done on recombination radiation of straight-band uniaxial single crystals of



CdSiAs<sub>2</sub> (width of the forbidden band 1.55 eV at 300 K) that are of interest from the standpoint of creating new optical systems in which the information carrier is the state of polarization of radiation. It is found that deviation of the composition of stoichiometric CdSiAs<sub>2</sub> toward an increase in the concentration of As or Cd is accompanied by formation of additional radiative and non-radiative recombination centers, causing quenching of recombination radiation, and especially of exciton band A. These single crystals can be used as the basis for sources of linearly polarized radiation and other functional devices that could not be produced with gallium arsenide crystals with isotropic crystal lattice. Figures 3, table 1, references 9: 6 Russian, 3 Western.  
[116-6610]

UDC 537..3128

#### SPIN RELAXATION OF CONDUCTION ELECTRONS IN MODERATELY DOPED GaAs CRYSTALS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 25, No 12, Dec 83  
(manuscript received 2 June 83) pp 3537-3642

MARUSHCHAK, V. A., STEPANOVA, M. N. and TITKOV, A. N., Physicotechnical Institute, USSR Academy of Sciences, Leningrad

[Abstract] In earlier research, M. I. D'yakonov and V. I. Perel' suggested a precessional mechanism of spin relaxation of conduction electrons in semiconductor crystals without inversion center (DP mechanism) due to spin splitting of the conduction band in such crystals. In this paper, the authors consider the temperature dependence of spin relaxation time of thermalized electrons in GaAs crystals with acceptor concentration of  $4 \cdot 10^{16} \text{ cm}^{-3}$ , enabling observation of the DP mechanism over a broad temperature range, investigation of the behavior of the mechanism, and determination of the magnitude of spin splitting of the conduction band for gallium arsenide. The constant of spin splitting of the conduction band is found to be  $\alpha = 0.070 \pm 0.005$ . Figures 2, references 20: 15 Russian, 5 Western.  
[151-6610]

## ANOMALOUS INFLUENCE OF ALUMINUM ADSORPTION ON GaAs EMISSION PROPERTIES

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 25, No 12, Dec 83  
(manuscript received 8 Jun 83) pp 3548-3553

BLAZHNOVA, Ye. I., KALGANOV, V. D. and MILESHKINA, N. V., Leningrad State University imeni A. A. Zhdanov

[Abstract] Field emission methods are used to study the initial stages of formation of a GaAs-Al contact, and an investigation is made of the effect of anomalous increase in emissivity of GaAs with aluminum adsorption. The specimens for study of emission properties were crystals of both conductivity types with different resistivities and atomically clean surface. The anomalous increase in emissivity of the crystals accompanying sputtering of submonatomic aluminum coatings cannot be explained in terms of the Fowler-Nordheim theory. This anomalous increase in emissivity corresponds to a reduction in the effective work function of GaAs to 2.3-2.4 eV. For a surface covered with the natural oxide, the effect is considerably less pronounced. A possible cause of the anomalous rise in emission current after adsorption may be a reduction in the emission of the initial surface associated with emission from the valence band of these crystals. Figures 6, references 10: 6 Russian, 4 Western. [151-6610]

INVESTIGATION OF SPECTRAL DEPENDENCES OF TWO-PHOTON ABSORPTION IN  $\text{ZnP}_2$  SINGLE CRYSTALS OF TETRAGONAL MODIFICATION

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 25, No 12, Dec 83  
(manuscript received 23 Mar 83, after revision 8 Jul 83) pp 3701-3703

BALTRAMEYUNAS, R., VISHCHAKAS, Yu., GAVRYUSHIN, V., KUBERTAVICHYUS, V. and TYCHINA, I., Vilnyus State University imeni V. Kapsukas

[Abstract] Spectral studies are done on two-photon absorption in zinc diphosphide by a two-beam method, using the first Stokes component of simulated Raman scattering of radiation from a neodymium-doped sphosphate glass laser in compressed hydrogen as the modulating radiation. This satisfies the fundamental condition of two-photon spectroscopy. The energy of the amplified Raman pumping pulse was about 1 J at duration of 25 ns. The high-pressure optical cell was 135 cm long. The specimens of red tetragonal modification were purposely undoped. Nonlinear absorption spectra were measured at 300 and 80 K. It is found that the spectral dependence of two-photon absorption in zinc diphosphide have a complex shape that increases more sharply with increasing photon energy than in the

case of the more thoroughly studied crystals of group  $A_2B_6$ . Two nonlinear absorption thresholds are observed at 0.18 and 0.28 eV from the two-photon absorption edge. It is possible that the complicated band structure of the compound is responsible for the spectral complexity. Figures 2, references 10: 8 Russian, 2 Western.  
[151-6610]

#### INFLUENCE THAT PUMPING INTENSITY HAS ON MIGRATION PROCESSES OF EXCITATIONS OF LOCALIZED EXCITONS IN SEMICONDUCTOR SOLID SOLUTIONS

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 39, No 2, 25 Jan 84 (manuscript received 21 Nov 83) pp 48-51

SUSLINA, L. G., ARESHKIN, A. G., MELEKHIN, V. G. and FEDOROV, D. L.,  
Physicotechnical Institute imeni A. F. Ioffe, USSR Academy of Sciences

[Abstract] The authors give the results of investigation of a new nonlinear effect in the optics of semiconductor solid solutions produced by processes of diffusion of excitations of localized exciton states: dependence of the luminescence spectrum of these states on the level of excitation. An expression is found relating the observed shift in the maximum of the luminescence line corresponding to these states as the level of excitation varies to dispersion of radiative lifetimes and density of states for an inhomogeneous contour of the line with consideration of migrations of excitations. Luminescence was excited in  $Zn_xCd_{1-x}S$  crystals with  $x$  ranging from 0 to 0.15 at 2 K by a helium-cadmium laser with maximum power of 10 mW when the beam was focused in a spot with diameter of 0.1-0.15 mm. Beam intensity was varied by calibrated neutral filters. It was found that increased pumping intensity shifts the line of localized exciton states toward the exciton resonance line, and redistributes intensity between the exciton luminescence line and a line corresponding to an exciton complex: the exciton bound to a neutral donor. The effect is interpreted as a spectroscopic manifestation of migration of electron excitations. Figures 2, references 9 Russian.  
[125-6610]

#### SURFACE ACOUSTIC PLASMONS IN pn JUNCTION

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 39, No 2, 25 Jan 84 (manuscript received 29 Nov 83) pp 51-53

BLANK, A. Ya. and GULYAYEV, Yu. V., Institute of Radio Engineering and Electronics, USSR, Academy of Sciences

[Abstract] Recent research has revealed low-frequency plasma waves (acoustic plasmons) in a semiconductor plasma. Such waves are characterized by a

linear dispersion law and have weak Landau damping, which is due to the fact that the phase velocity of the wave lies between the Fermi velocities of two groups of carriers because of the difference in effective masses. In this paper, the authors consider the appreciably inhomogeneous situation where two components having different masses, such as electrons and holes, are spatially separated. This case is met in a pn junction or a metal-semiconductor interface. It is found that in this situation propagation of a surface wave may be observed with electric field damped on both sides of the interface. The physical cause of surface wave propagation is that permittivity is negative in the medium with heavy carriers, while the electric field of the wave in the medium with light carriers is static, and is shielded by the Coulomb interaction of the carriers. The unusual dispersion of the surface wave distinguishes it from the acoustic plasmon. The presence of an interface places no appreciable constraints on existence of the surface wave. References 6: 4 Russian, 2 Western.  
[125-6610]

#### FOCUSING BEAM OF 1-GeV PROTONS WITH VOLUMETRIC CAPTURE TO THE MODE OF CHANNELING BY BENT SINGLE CRYSTAL

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 39, No 2, 25 Jan 84 (manuscript received 21 Oct 83) pp 58-61

ANDREYEV, V. A., BAUBLIS, V. V., DAMASKINSKIY, Ye. A., KRIVSHICH, A. G., KUDIN, L. G., MARCHENKOV, V. V., MOROZOV, V. F., NELYUBIN, V. V., ORISHCHIN, Ye. M., PETROV, G. Ye., RYABOV, G. A., SAMSONOV, V. M., SAMSONOV, L. E., SPIRIDENKOV, E. M., SULIMOV, V. V., SUMBAYEV, O. I. and SHCHEGEL'SKIY, V. A., Institute of Nuclear Physics imeni B. P. Konstantinov, USSR Academy of Sciences

[Abstract] It has been demonstrated in previous research that a bent single crystal has the ability to capture particles to the channeling mode in a range of angles that are much larger than the Lindhard angle. The essence of this effect, called "volumetric capture," is that the conditions of capture to the channeling mode for particles may arise in the body of a crystal in regions where the particle trajectories coincide with the tangent to a bent crystallographic plane or axis. Thus, capture is possible for particles of the incident beam inside the entire angle between tangents to the bent plane within the limits of the crystal. In this paper, it is experimentally shown that particles captured into the channeling mode from a wide angle interval have a narrower angular distribution at the output from a bent crystal, i.e., a focusing effect is realized. Protons with 1-GeV energy in volumetric capture by the (111) plane of a bent silicon crystal from an angular interval with FWHM = 7.2 mrad had an angular divergence at the output from the crystal with FWHM = 1.6 mrad. A reduction by a factor of 1.8 was observed in the phase volume of the beam of channeled particles. Figure 1, reference 1 Russian.  
[125-6610]

## POLARIZATION RATIO AND TEMPERATURE DEPENDENCE OF BRAGG REFLECTION INTENSITY FOR LiF DISLOCATION SINGLE CRYSTALS

Minsk VESTSI AKADEMII NAVUK BSSR: SERYYA FIZIKA-MATEMATYCHNYKH NAVUK  
in Russian No 6, Nov-Dec 83 (manuscript received 14 Apr 83) pp 53-56

OLEKHNOVICH, N. M. and PUSHKAREV, A. V., Institute of Solid State and  
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[Abstract] The paper gives the results of an investigation of the polarization ratio  $\rho_{\pi}/\rho_{\sigma}$  and the parameters of temperature dependence of integral intensity  $(\rho)\alpha = d \ln \rho / d \ln F_T$  where  $F_T$  is a structure factor) for LiF single crystals with dislocation density  $N_d = 10^3$ - $10^6 \text{ mm}^{-2}$ . Reflections 200, 400 and 600 were studied in Mo  $K_{\alpha}$  radiation. It is shown that in the region of small dislocation densities  $N_d < 10^5 \text{ mm}^{-2}$ ,  $\rho_{\pi}/\rho_{\sigma}$  and  $\alpha$  reach extremum values that depend on the order of the reflection. It is found that for reflection 200 in the region of the extremum  $\rho_{\pi}/\rho_{\sigma} > 1$ ,  $\alpha < 0$ . The dependence of the investigated parameters on the extinction factor at  $N_d > 10^5 \text{ mm}^{-2}$  is quantitatively explained on the basis of the mosaic model of a crystal with independent mosaic blocks. Figures 2, table 1, references 9: 6 Russian, 3 Western.  
[133-6610]

UDC 621.373.826:535.21:539

RADIATION STRENGTH OF INDIUM ANTIMONIDE ON WAVELENGTH OF 10.6  $\mu\text{m}$ 

Minsk VESTSI AKADEMII NAVUK BSSR: SERYYA FIZIKA-MATEMATYCHNYKH NAVUK  
in Russian No 6, Nov-Dec 83 (manuscript received 29 Apr 82) pp 62-65

VALYAVKO, V. V., KEVORKOV, M. N., OSIPOV, V. P. and POPKOV, A. N.,  
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[Abstract] An investigation is made of surface radiation strength of single crystals of indium antimonide with free carrier concentration of  $10^{14}$ - $10^{18} \text{ cm}^{-3}$  and orientations of  $\langle 111 \rangle$  and  $\langle 211 \rangle$  when specimens are subjected to isolated pulses of emission from a TEA  $\text{CO}_2$  laser. Pulses were linearly polarized with duration of about 100 ns, and energy up to 0.6 J on a wavelength of 10.6  $\mu\text{m}$ . A diaphragm cut off the most spatially homogeneous part of the laser beam with intensity variation of no more than 20%. The radiation was focused on the specimen, part of the beam being diverted by a beam splitter to instrumentation for energy measurement. The threshold of destruction of the specimens was determined by visual inspection under a microscope. The results show that in the range of electron concentrations of  $10^{14}$ - $10^{18} \text{ cm}^{-3}$ , radiation strength of InSb on the given

wavelength is independent of concentration, being  $20 \pm 5 \text{ MW/cm}^2$ , which agrees satisfactorily with the theoretical value of  $22 \text{ MW/cm}^2$ . The radiation strength of the specimens was found to be practically independent of crystallographic orientation. It is shown that at radiation power density near the threshold value, surface damage is periodic. This effect can be attributed to interference between the incident wave and the resultant surface wave. Figures 3, references 4: 2 Russian, 2 Western. [133-6610]

UDC 621.315.592

#### INVESTIGATION OF PROCESS OF PRODUCING ZnSe FILMS BY METHOD OF PULSED LASER VAPORIZATION

Minsk VESTSI AKADEMII NAVUK BSSR: SERYYA FIZIKA-MATEMATYCHNYKH NAVUK  
in Russian No 6, Nov-Dec 83 (manuscript received 10 Feb 82) pp 81-84

KOREN', N. N., GREMENOK, V. F. and MOISEYENKO, V. V., Institute of Solid State and Semiconductor Physics, BSSR Academy of Sciences

[Abstract] The paper gives the results of experiments on sputtering thin films of zinc selenide in vacuum by pulsed laser vaporization. The process was done in a vacuum chamber at pressure of  $(4-6) \cdot 10^{-6} \text{ mm Hg}$  by a laser in free emission on a wavelength of  $1.06 \mu\text{m}$  with pulse duration of 1.1 ms. The beam was focused on the surface of a molded power ZnSe tablet at an angle of incidence of  $45^\circ$ . The products of vaporization were deposited on glass backings parallel to the target at a distance of 70-85 mm. An investigation was made of the effect that defocusing the laser beam has on quality of the sputtering process. Defocusing was varied by increasing the distance between the focusing lens and the target in a range of  $(1-1.4)f$ . It is found that defocusing can minimize the number of macrodefects: gaps, pinholes and blisters. The optimum distance is 1.3 f. The corresponding depression formed on the target with this degree of focusing is much shallower than its diameter. Figure 1, table 1, references 7 Russian. [133-6610]

## FLUID DYNAMICS

### PARAMETERS OF DETONATION WAVES EXCITED IN GAS DURING CONCENTRATED RELEASE OF ENERGY

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 19, No 6, Nov-Dec 83  
pp 76-82

TROTSYUK, A. V. and UL'YANITSKIY, V. Yu., Novosibirsk

[Abstract] Parameters of plane and cylindrical detonation waves originating at a powerful source in a gaseous explosive medium were determined experimentally in two flat channels, one having a cross section of 10 x 10 mm for plane waves and one 400 x 180 x 10 mm with inserts forming cylindrical sectors. Measurements were made by the optical method with photodetectors recording the cellular wavefront along its entire path and, through a slit, the evolution of spontaneous glow. These measurements, in qualitative agreement with available theoretical numerical data, reveal that the dimensionless velocity (normalized to steady-state velocity) of both plane and cylindrical waves declines rapidly with increasing distance from the origin and that a wavefront cell in an overcompressed cylindrical wave declines rapidly with increasing wave velocity. These results are formalized in a mathematical model describing the decay of overcompressed detonation waves, first in the approximation of instantaneous chemical reaction and then including the time delay of energy release behind the wavefront. Such a time delay, in the case of a weak energy source, reflects a detonation wave with a velocity nonmonotonically depending on the distance from that source. Figures 4, references 15: 13 Russian, 2 Western.  
[154-2415]

### LINEAR LONG-WAVE STABILITY OF CYLINDRICAL STEADY LAMINAR FLAME IN ROTATING MEDIUM

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 19, No 6, Nov-Dec 83  
(manuscript received 9 Jun 82) pp 36-41

LAZAREV, P. P. and PLESHANOV, A. S., Moscow

[Abstract] The stability of a steady laminar flame front in a rotating medium is analyzed in the linear approximation with respect to perturbation

amplitude, taking into account the effect of the centrifugal force and the Coriolis force as well as of hydrodynamic perturbations of a wavelength larger than the thermal width of the flame front. The incompressible non-viscous fluid is assumed to rotate at a constant angular velocity about the axis of the cylindrical flame. The corresponding system of equations of motion and continuity is solved for the appropriate boundary conditions at the flame front, with the flow either occurring outside the cylinder and the fuel mixture entering from a source. The solution, which in both cases converges to the Landau limit, indicates that the Coriolis force does not influence the stability of the flame front. It also confirms the physical fact that the centrifugal force raises the stability when flow occurs inside the cylinder and lowers the stability when flow occurs outside the cylinder. Figures 4, references 3 Russian. [154-2415]

UDC 532.516

#### NONSTEADY MOTION OF SOLID SPHERE IN COMPRESSIBLE VISCOUS FLUID

Kiev PRIKLADNAYA MEKhanika in Russian Vol 19, No 8, Aug 83  
(manuscript received 23 Sep 82) pp 118-121

BASMAT, A. S., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] The problem of nonsteady motion of a solid body in a fluid medium is solved for a solid sphere in a compressible viscous fluid. An exact solution being mathematically very difficult to obtain, an approximate one is sought through linearization of the corresponding equations of motion. A perfectly rigid sphere is assumed to move in a quiescent boundless Stokes fluid with mechanical properties characterized by density and acoustic velocity. The motion of the sphere is described in two systems of coordinates, a Cartesian one and a spherical one with common origin. Its translational motion along one of the Cartesian axes is characterized by a velocity  $V(t)$  that varies in time. The boundary conditions are adhesion at the surface of the sphere and vanishing of perturbations at infinity. The vector equation of motion is reduced to two partial differential equations for the scalar potential and the vector potential in the fluid, the vector potential being expressible through another scalar potential in the case of axial symmetry. The solution is obtained with the aid of a Laplace transformation, assuming zero initial conditions. The drag force of the fluid is calculated with the aid of asymptotic expansion for the special case of constant acceleration. Other special limiting cases are an incompressible viscous fluid such as glycerin and an elastic solid medium such as iron. Figure 1, references 7: 6 Russian, 1 Western. [173-2415]



## DIFFRACTION OF PLANE POLARIZED WAVES BY NONCIRCULAR CYLINDRICAL CAVITY

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 19, No 8, Aug 83  
(manuscript received 29 Jun 82) pp 19-23

KOLODIY, V. I. and SHUL'GA, N. A., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] Diffraction of plane waves by noncircular cylindrical cavities is analyzed by solution of the corresponding Helmholtz equations in the appropriate system of curvilinear coordinates. Such a cavity, generated by revolution of a regular  $(N + 1)$ -gon with rounded corners or an ellipse ( $N = 1$ ), is assumed to exist inside an elastic isotropic medium through which a plane longitudinal wave propagates. With the wave potential expressed in the form of a Bessel double exponential series in two coordinates, the two Helmholtz equations reduce to an infinite system of algebraic equations for the series coefficients. For a given  $N$  this system splits into  $(N + 1)$  independent ones. It has been solved approximately, with retention of only a finite number of equations corresponding to up to 9 such terms in each of the two summations. The dynamic stress distribution around such a cavity, produced by the resultant wave field, has been calculated numerically on the basis of this solution for various wave numbers, wave frequencies, incidence angles, and cavity cross sections (elliptic, circular, square). The stresses are found to depend nonmonotonically on the wave number. The results for low wave frequencies agree with results obtained by the A. N. Guz' method of perturbations, the latter method converging more slowly for higher wave frequencies. The results also agree within 5% with results obtained by asymptotic methods and by resolution into spherical or cylindrical waves. Figures 4, references 5 Russian.

[173-2415]

UDC 533.6.011.5:532.582.3

## INVESTIGATION OF SUPERSONIC UNSTEADY FLOW AROUND CONICAL BODIES

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 2, Mar-Apr 83 (manuscript received 10 Dec 81) pp 174-177

LIPNITSKIY, Yu. M., REZNICHENKO, Yu. T. and SIRENKO, V. N.

[Abstract] Spatial supersonic flow of an ideal gas about conical bodies oscillating harmonically in the plane of the angle of attack with respect to a certain angle  $\beta_0$  described by the principle  $\alpha = \alpha_0 \cos \omega t$  such that the combined angle of attack  $\beta = \beta_0 + \alpha_0 \cos \omega t$  is examined. The numerical solution of the complete system of equations of gas dynamics agrees well with the laws of similarity. References 6: 5 Russian, 1 Western.

[186-6900]

## COMPACT INVERSION OF SUPERSONIC PLANAR FLOW

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 2, Mar-Apr 83 (manuscript received 24 Apr 81) pp 171-174

RYLOV, A. I.

[Abstract] The smallest inverting channel among a class of channels proposed elsewhere and based on the use of the "potential eddy" current is constructed and investigated numerically. The channel dimension is obtained numerically as a function of the Mach number of the initial flow. An inverting channel is proposed that is based on repeated utilization of isentropic compressive waves. The smallest inverting channel for moderate and large Mach numbers of the initial flow is extremely small, with the transverse dimensions becoming smaller as the initial Mach number increases.

References 6: 5 Russian, 1 Western.

[186-6900]

## STEADY-STATE SELF-SIMILAR TURBULENT JETS OVER POINT CONCENTRATION-HEAT SOURCE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 2, Mar-Apr 83 (manuscript received 15 Sep 81) pp 129-135

GOSTINTSEV, Yu. A., SUKHANOV, L. A., SOLODOVNIK, A. F.

[Abstract] This study presents the findings from an investigation of steady-state turbulent weakly twisting jets over a concentration heat source. The results indicate that, for the Prandtl models as well as for the Dasil'chenko hypothesis for  $Pr \approx 6$ , there is a similarity between the profiles of excess density, temperature, concentration and vertical velocity; for  $Pr = Sc < 0.6$  the thermal (concentration) boundary layer is wider than the dynamic layer; for  $Pr = Sc > 0.6$  the boundary layer is wider. References 10: 6 Russian, 4 Western.

[186-6900]

## ASYMPTOTIC LAWS OF ATTENUATION OF SHOCK WAVES IN HETEROGENEOUS MEDIA

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian  
No 2, Mar-Apr 83 (manuscript received 13 Oct 80) pp 97-101

LEVIN, V. A. and SVALOV, A. M.

[Abstract] Attenuation principles are derived for shock waves propagating through a medium with arbitrary density and pressure distribution and with arbitrary energy, mass and momentum sources, i.e., for the case in which the flow following a jump in the Riemann wave is not described in the main term. When mass, energy and momentum sources are present, the conditions for shock wave attenuation depend upon the combined effect of these sources, which is determined by a certain generalized parameter. When the source terms are discontinuous on the characteristics, which approximate the behavior of the function as they grow abruptly, there can be no asymptotic attenuation: the shock wave either fails to attenuate, or degenerates to a weak discontinuity at a finite distance from its point of inception. References

6 Russian.

[186-6900]

UDC 550.32

## ANOMALIES OF SHOCK WAVE AND OF ISENTROPIC WATER COMPRESSIBILITY

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 19, No 5, Sep-Oct 84  
pp 149-153

SHARIPDZHANOV, I. I., AL'TSHULER, L. V. and BRUSNIKIN, S. Ye., Moscow

[Abstract] A precise plot of the Hugoniot adiabat on the basis of highly accurate absolute measurements of water compressibility under shock waves reveals an anomaly in the form of an inflection within the  $\mu = 1.84-2.13$  km/s and  $p = 9-11.5$  GPa range. This anomaly has been variously attributed to "phase transition" from water to ice VII, to dissociation into an ionic melt with appearance of electrical conductivity, to an increase of the fraction of dense ice VII clusters, or to a sharp increase of the number of nearest neighbors in the lattice approaching a coordination number of 12. A caloric equation of state as well as the equations of pressure-volume ( $p$ - $V$ ) and pressure-temperature ( $p$ - $T$ ) isentropes are subsequently derived with empirical parameters on the basis of this water compressibility anomaly and corresponding values of dissociation parameters, taking into account thermal volume expansion as well as isentropic bulk compression. From these equations the authors plot phase diagrams for water and shock adiabats with initial states on the liquid-vapor equilibrium line. The corresponding

anomalies of isentropes have been calculated by numerical methods from approximations of the  $pV(H,p)$  function and the  $\frac{\alpha pV}{c_p}(H,p)$  function ( $H$  - enthalpy,  $p$  - pressure,  $V$  - volume,  $\alpha$  - coefficient of thermal volume expansion) in the high-pressure range. Collocation of upper and lower segments of these isentropes yields a wide range with  $\frac{\alpha pV}{c_p} < 0$  and thus negative  $\alpha$  and Grueneisen coefficient. A definitive interpretation of this anomaly and determination of transition equilibrium line will require measurement of shock compression of water with low density in initial states. Figures 4, tables 2, references 26: 13 Russian, 13 Western.  
[196-2415]

UDC 532/593

#### ATTENUATION OF SHOCK WAVES IN CONDENSED SUBSTANCES

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 19, No 5, Sep-Oct 84  
pp 135-138



VOSKOBOYNIKOV, I. M., DOLGOBORODOV, A. Yu. and AFANASENKOV, A. N., Moscow

[Abstract] Shock waves in condensed substance of short duration and a study of their attenuation in such substances requires a method with high time resolution. A study was made, accordingly, by the electron-optical method using two photomultipliers (FEU-119, FEU-92) and two oscillographs (SI-74, OK-33) for recording with a time resolution of 0.3  $\mu$ s. The approximately exponential pressure dependence of the wavefront glow intensity ensured a high accuracy of pressure determinations. Measurements were made of shock wave attenuation in carbon tetrachloride with reduced optical density and in tetranitromethane after detonation of short RDX charges (density  $\rho_0 = 1.71$  g/cm<sup>3</sup>) or TNTTRDX charges (density  $\rho_0 = 1.67$  g/cm<sup>3</sup>). The results are interpreted and analyzed on the basis of pressure velocity and distance-time diagrams, with a polytropic isentrope  $p = Ap^n$  for the explosion products and a shock adiabat  $D = c_0 + Bu$  for the medium ( $p$  - pressure,  $u$  - velocity). On the basis of close agreement between theoretical and experimental data, it is possible to evaluate the attenuation of shock waves in opaque substances such as a 1 mm thick aluminum plate or potassium iodide before an RDX charge in carbon tetrachloride. Figures 5, references 3 Russian.  
[196-2415]

## ATTENUATION OF AIR SHOCK WAVE BY MEANS OF PERFORATED BARRIERS

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 19, No 5, Sep-Oct 84  
pp 115-116

KLAPOVSKIY, V. Ye., MINEYEV, V. N., GRIGOR'YEV, G. S., VERSHININ, V. Yu.  
and LOGVENOV, A. Yu., Moscow

[Abstract] Attenuation of air shock waves by perforated barriers was studied in an experiment using two different barriers. Both were constructed by arraying No. 2 steel angle sections (equal legs), one into a  $\rightarrow$   pattern periodically deflecting the air stream by 90° and one into a  $\rightarrow$   pattern periodically compressing and expanding it. Measurement of the amplitude attenuation coefficient K revealed that the first barrier was more effective than the second one, with  $K = 4.44 \pm 1.17$  and  $K = 2.84 \pm 0.49$  respectively for a shock wave with a 2.12 MJ energy content 1 m before the barrier entrance. This indicates that the effectiveness of a barrier is determined not only by its perforation factor but also by its configuration. On the basis of these results two different test chambers were subsequently built with open roof and with a fixture for the source of air shock waves at the geometrical center: one a perforated circular cylindrical shell consisting of symmetrically spaced alternate No. 22 steel I-bars and No. R 43 steel rails, one a circular cylindrical shell of reinforced concrete with a 1.4% steel ratio behind a uniform coaxial array of steel rods. Figures 2, references 1 Czech.  
[196-2415]

## CALCULATING FLOW AROUND BLUNT BODIES WITH CONSIDERATION OF EMISSION

Moscow ZHURNAL VYCHISLITEL'NOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 23, No 5, Sep-Oct 83 (manuscript received 4 Aug 81, after revision 29 Oct 81) pp 1205-1213

SKOTNIKOV, A. P., SKOTNIKOV, V. P. and FOMIN, V. N., Moscow

[Abstract] A difference scheme of straight-through calculation based on the coarse particle method is proposed for solving problems of flow of a dissociated, ionized and radiating gas around blunt bodies. Results are compared for calculations using the  $P_1$ -approximation of the method of spherical harmonics, and the plane-layer approximation to account for radiation. An examination is made of flow with injection into a shock layer, simulating ablation of a heat shield under the action of an intense radiant heat flux incident on the surface of a blunt body. The two approximations are found to be equivalent for studying flows of radiating gas. Figures 7, table 1, references 12 Russian.  
[143-6610]

## SOLUTION OF A PROBLEM OF OSEEN FLOW AROUND A BODY

Moscow ZHURNAL VYCHISLITEL'NOY MATEMATIKI I MATEMATICHESKOY FIZIKI  
in Russian Vol 23, No 5, Sep-Oct 83 (manuscript received 18 Jul 81)  
pp 1254-1257

HOANG DINH DUNG, Moscow

[Abstract] The author considers planar flow of a viscous liquid around a wing in the Oseen scheme, with positive velocity at infinity, the vector being directed parallel to the  $Ox$  axis. Boundary value problems are considered for an arbitrary analytical function of a complex variable and for a MacDonald function, and the behavior of these functions on the wingtips is analyzed. Figure 1, references 9: 5 Russian, 4 Western.  
[143-6610]

## GEOMETRIC CHARACTERISTICS OF TURBULENT BOUNDARY LAYER SEPARATION UPON INTERACTION WITH DIRECT SHOCK WAVE IN CONICAL FLOWS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian  
No 6, Nov-Dec 83 (manuscript received 16 Aug 82) pp 43-51

ZUBIN, M. A. and OSTAPENKO, N. A., Institute of Mechanics, Moscow State University

[Abstract] Experimental results of previous research are used to analyze the influence that determining parameters have on the dimensions of the separated flow region that arises when a direct shock wave is incident on a turbulent boundary layer in conical flows. Empirical relations are proposed that permit calculation of the dimensions of this region and its position relative to the incident shock wave or the direction of the unperturbed flow. It is shown that the acute angles that the lines of separation and reattachment of the boundary layer make with the direction of the unperturbed flow are independent of the glancing angle of the leading edge, and are determined only by the intensity of the incident shock wave and the Mach number of the unperturbed flow. Simple approximations for the position of the line of separation are used to determine the critical Mach number and the critical pressure differential that lead to separation of the turbulent boundary layer. Figures 7, tables 2, references 21: 11 Russian, 10 Western.  
[160-6610]

# INVESTIGATION OF HEAT EXCHANGE ON MODELS IN SUBSONIC JETS OF INDUCTION PLASMATRON

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 6, Nov-Dec 83 (manuscript received 1 Jul 82) pp 129-135

GORDEYEV, A. N., KOLESNIKOV, A. F. and YAKUSHIN, M. I., Moscow

[Abstract] The paper gives the results of studies of flow parameters in an induction plasmatron and heat exchange on air-cooled models in subsonic jets of dissociated air in the pressure range of  $5 \cdot 10^3$ – $1.0 \cdot 10^5$  N/m<sup>2</sup>. The resultant experimental data completely confirm present theoretical notions about the influence that the catalytic nature of materials has on heat exchange in dissociated air flows. Experimental data on heat flux at low pressures give an idea of the comparative catalytic activity of materials. Numerical values of the level of catalytic activity can be determined by comparing experimental data with the results of numerical analysis of heat exchange when dissociated air flows around a model with consideration of nonequilibrium chemical reactions that occur in the flow and on the surface. A numerical solution is found for the problem of flow of a subsonic jet of viscous heat-conducting gas around a model of cylindrical shape with flat ends. Figures 6, references 15: 12 Russian, 3 Western. [160-6610]

# DENSITY DISTRIBUTION IN SUPERSONIC JET DISCHARGED INTO VACUUM FROM NOZZLE WITH BEVEL TIP

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 6, Nov-Dec 83 (manuscript received 3 Jun 82) pp 179-180

RODIONOV, A. V., Moscow

[Abstract] Effective methods are now available for figuring axisymmetric jets of inviscid perfect gas discharged into vacuum, and approximations have been found for the density field in such jets far from the nozzle tip. If the plane of the nozzle tip is not perpendicular to the nozzle axis, flow in the jet becomes three dimensional. In some cases, the influence of a bevel tip can be accounted for with good accuracy by introducing a correction into the density distribution. The author derives an expression for such a correction based on calculations in which the flow from a source is assigned on the nozzle exit. The limits of applicability of the proposed correction are determined. Figures 2, references 5 Russian. [160-6610]

UDC 621.373.826.038.825.3

LIMITING EFFECTIVENESS OF GENERATION OF EMISSION HARMONICS OF NEODYMIUM LASER

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian  
Vol 47, No 10, Oct 83 pp 1910-1918

BEGISHEV, I. A., GULAMOV, A. A., YEROFYEV, Ye. A., REDKORECHEV, V. I.  
and USMANOV, T.

[Abstract] This study presents the findings of an investigation of the limiting effectiveness of conversion of the emission of a phosphate-glass laser, with 500 ps pulse duration, to the 2nd, 3rd and 4th harmonics. Ninety percent efficiency is achieved experimentally in converting energy to the 2nd harmonic. The efficiency of cascade 3rd-harmonic generation is determined entirely by the space-time modulation of radiation, assuming that the requirements of high-efficiency 2nd harmonic generation are satisfied in the first crystal. 3rd-harmonic generation efficiency of 80% is achieved. 2nd-to-4th harmonic conversion efficiency of 92% is obtained, indicating that the process described can be employed in LTS laser-driven fusion experiments. Figures 5, references 10: 7 Russian, 3 Western.  
[162-6900]

UDC 621.378.325

SPACE-TIME CHARACTERISTICS OF RADIATION OF SINGLE-MODE INJECTION LASERS

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 12, Dec 83  
(manuscript received 2 Dec 82) pp 2408-2410

BORODULIN, V. I., ZVERKOV, M. V., KONYAYEV, V. P., LAMANOV, A. L.  
PASHKO, S. A., TRAPEZNIKOV, M. B. and SHVEYKIN, V. I.

[Abstract] Findings are presented from investigations of the space-time heterogeneity of radiation in injection lasers operating in the zero transverse mode. Injection lasers with transverse pn junction and with a mesa-strip junction 5  $\mu\text{m}$  wide prepared by selective removal of the junction layer



are examined. A minimum variation in  $\delta\tau_{\max}$  is observed with the injection laser operating in the spontaneous mode (i.e., with pumping current smaller than  $0.6 I_{\text{thr}}$ ) and during lasing in which only one transverse mode is excited. When the pumping mode is appropriately selected, injection lasers with transverse pn-junction and mesa-strip junction have comparable characteristics from the viewpoint of space-time heterogeneity. Injection lasers employing a transverse pn junction are a more promising radiation source for devices in which high optical power is not required ( $< 0.3$  MW) but in which the modulation percentage and high optical signal repetition frequencies are important. Figure 3, references 8 Russian.  
[152-6900]

UDC 535.568.1

#### POLARIMETER FOR CO<sub>2</sub> LASER

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 39, No 3, Sep 83  
(manuscript received 20 Oct 82) pp 499-503)

SNOPKO, V. N. and TSARYUK, O. V.

[Abstract] A polarimeter is described in which the measurement system is made insensitive to spatial heterogeneity of the radiation beam. The operation of the device is demonstrated by measuring the degree of polarization of linearly polarized radiation from a CO<sub>2</sub> laser with respect to the main planes of the polarimeter as it rotates about its optical axis. Absolute measurement errors are determined for different diffuser types. Figures 3, references 6: 5 Russian, 1 Western.  
[153-6900]

UDC 539.1

#### PARAMETRIC BEAM INSTABILITY IN ARRAY OF RELATIVISTIC OSCILLATORS

Minsk DOKLADY AKADEMII NAUK BELORUSSKOY SSR in Russian Vol 27, No 11, Nov 83  
(manuscript received 28 Feb 82) pp 995-998

BARYSHEVSKIY, V. G. and FERANCHUK, I. D., Belorussian State University imeni V. I. Lenin

[Abstract] Coherent gaser and xaser sources have been proposed that operate similarly, to coherent generators of microwave electromagnetic radiation, namely, with population inversion at resonance transitions of Mössbauer nuclei or at inner shells of heavy atoms. The crystal itself, with permittivity varying periodically in space and with a particle beam oscillating upon excitation by a laser wave or upon radiative transitions between

transverse-motion zones, constitutes the corresponding analog of a corrugated metal wall. Parametric excitation by a modulated beam of ultra-relativistic electrons with moderate current density of  $1-10 \text{ A/cm}^2$  has already been found to produce  $\gamma$ -ray or x-ray emission in a crystal. However, solution of the self-consistent system of equations of motion describing interaction of the oscillator array in a resonator with three-dimensionally variable permittivity and the radiation field reveals conditions under which longitudinal beam instability will occur. When the Bragg condition is satisfied, the solution of the corresponding dispersion equation has a negative part and the latter represents buildup of an electromagnetic wave in the crystal with attendant parametric beam instability. This buildup and conditions for its saturation will be analyzed in another study. Article was presented by Academician (BSSR Academy of Sciences) M. A. Yel'yashevich. References 8: 7 Russian, 1 Western.  
[174-2415]

UDC 621.378.525

#### SIGNAL/NOISE RATIO OF REGENERATIVE LASER

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 39, No 3, Sep 83  
(manuscript received 4 Jun 82) pp 478-480

LEDNEVA, G. P. and CHEKALINSKAYA, Yu. I.

[Abstract] The influence of the parameters of a regenerative laser on the signal/noise ratio during reception of radiation from a multi-mode laser is investigated. It is demonstrated that the use of a regenerative laser as a filter improves the sensitivity of reception of radiation from a multi-mode laser significantly. References 3 Russian.  
[153-6900]

UDC 535.21:621.378

#### INFLUENCE OF MICROSTRUCTURE OF POLYDISPERSE AQUEOUS AEROSOL ON PARAMETERS OF AEROSOL DISPERSAL BY LASER RADIATION

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 39, No 3, Sep 83  
(manuscript received 18 Jun 82) pp 397-402

PUSTOVALOV, V. K. and KHORUNZHIY, I. A.

[Abstract] The influence of the microstructure of the aerosol on the parameters of the laser dispersal process is examined numerically by computer. A gamma distribution of the most probable drop radius of  $r = 25, 5, 7.5$  and  $10 \mu\text{m}$  is employed. Figures 3, references 3 Russian.  
[153-6900]

## INVESTIGATIONS OF LONGITUDINAL PULSE-PUMPED DYE LASERS

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 39, No 3, Sep 83  
(manuscript received 12 Jul 82) pp 390-396

ITSKHOKI, I. Ya., SEREGIN, S. L. and CHEREDNICHENKO, O. B.

[Abstract] Dye lasers are investigated on the basis of a theoretical approach employing numerical solution of partial differential balance equations for the intensity of the traveling waves and the populations of the levels of the active medium. Type ILZhI-501 and LZhI-501 lasers are studied in numerical experiments to investigate the characteristics of the development of lasing at different points in the tuning band, as well as the dynamics of the variation of level populations. The influence of internal losses of pumping radiation, the spectral selector width and variation in resonator length on the pulse development time and shape and lasing efficiency are studied. Figures 4, references 10: 7 Russian, 3 Western.  
[153-6900]

## INFLUENCE OF SECONDARY ELECTROOPTICAL EFFECT ON EMISSION OF NEGATIVE FEEDBACK LASERS

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 39, No 3, Sep 83  
(manuscript received 5 May 82) pp 384-389

AZASHKOV, A. V. and MORGUN, Yu. F.

[Abstract] The influence of the secondary electrooptical effect on the stability of the quasicontinuous mode of lasers with negative electrooptical feedback is investigated experimentally. The findings indicate that it is necessary to suppress all of the mechanical resonances of an electrooptical Q-switching crystal operating in the smooth millisecond pulse mode. The data indicate that the secondary electrooptical effect is promising for obtaining a regular pulsation mode in lasers with negative feedback. Figures 5, references 11: 9 Russian, 2 Western.  
[153-6900]

# THEORETICAL ANALYSIS OF PHYSICAL PROCESSES OF LASING MEDIUM DEGRADATION IN SEMICONDUCTOR LASERS

Moscow TRUDY ORDENA LENINA FIZICHESKOGO INSTITUTA IMENI P.N. LEBEDEVA  
AKADEMII NAUK SSSR: INZHEKTSIONNYYE LAZERY in Russian Vol 141, 1983  
pp 154-185

YELISEYEV, P. G., ZAVESTOVSKAYA, I. N., POLUEKTOV, I. A. and POPOV, Yu. M.

[Abstract] While the accumulated experimental data on the degradation of semiconductor lasing media attests to the influence of excess current carrier recombination on the rate of defect reactions in the semiconductors, the mechanism of this influence is theoretically unclear. This is primarily because no specific model has been worked out for the elementary event of the conversion of the electron-hole pair energy to the kinetic energy of the atom (or defect) in the lattice which allows an accurate calculation of the event probability even in cases where it is extremely low. This paper proposes a defect formation mechanism based on the resonant capture of an electron in the resonant repulsive state of a composite system formed by the trapping center and the electron (resonant defect-forming capture). The topics covered in developing this model are: 1) role of electron stimulated defect reactions in the gradual degradation of semiconductor lasers; 2) mechanisms of defect formation and defect migration with the interaction of electron excitation and the lattice; 3) resonant states of deep centers; 4) mechanism of defect formation during resonant capture of excess current carriers at a deep center; 5) cross-section of the defect-forming resonant capture of an electron; 6) resonance level self-ionization width; 7) influence of electron-phonon interaction on the characteristics of resonant defect-forming capture of an electron; 8) probability of resonant defect-forming capture of an electron; 9) mechanisms of the acceleration of defect diffusion and dislocation climb; 10) impact of excess current carriers on dislocation climb processes; 11) threshold effects with dislocation climb in a medium having obstacles under conditions of intense pumping; 12) the "focal source" degradation model; 13) kinetics of uniform aging of semiconductor lasers and light-emitting diodes. It is shown that the effective cross-section of the process of electron capture by the "deep capture center + electron" system is determined by the ratio of the electron lifetime in the resonant state to the atom skip time. The rate of stimulated dislocation migration is a linear function of the laser pumping intensity, and when a certain threshold is reached, increases with a jump up to values corresponding to the travel of the dislocation in the crystal lattice relief undistorted by defects. Together with the dislocation migration process, this stimulated travel is the reason for the rise in the dislocation density at focal points of accelerated degradation of laser crystals. While this degradation model is considered to be proved by comparisons with available data, it is noted that a more detailed interpretation of some results requires more precise specification of the nature of the deep centers. Figures 8, tables 2, references 85: 46 Russian, 39 Western. [27-8225]

## STUDY OF PLANAR STRIPE GEOMETRY AlGaAs-GaAs HETEROSTRUCTURE LASERS

Moscow TRUDY ORDENA LENINA FIZICHESKOGO INSTITUTA IMENI P.N. LEBEDEVA  
 AKADEMII NAUK SSSR: INZHEKTSIONNYYE LAZERY in Russian Vol 141, 1983  
 pp 89-117

YELISEYEV, P. G., OKHOTNIKOV, O. G., PAK, G. T. and VU VAN LYK

[Abstract] Considerable work has been done on room temperature, CW stripe geometry AlGaAs/GaAs heterostructure lasers since their discovery in 1970. This paper generalizes the considerable experimental data on these lasers and cites additional studies that clear up particular features of their behavior. A phenomenological theory is put forward for the hysteresis effects and electrical characteristics that are observed and the capability of reconstructing the shape of current-power characteristics from electrical measurements alone is demonstrated. Confirmation of the theory is found in the single frequency peakless operation of such a laser by means of a dynamic temperature waveguide. The review treats the following topics: 1) procedural questions of measurements of laser parameters, including differential curves; 2) general properties and classification of the samples studied with respect to the current-power characteristic; 3) nonlinear and hysteresis current-power characteristics and their analysis from the viewpoint of a self-focusing instability model; 4) the differential electrical characteristics and their relationship to the current-power characteristic; 5) study of a pulsed planar stripe geometry heterostructure laser, followed by an appendix that provides an analytical derivation of formulas for the differential resistance of a laser diode. Figures 29, tables 4, references 33: 18 Russian, 15 Western.  
 [27-8225]

## STUDY OF CW INJECTION LASER WITH A DISPERSIVE EXTERNAL CAVITY

Moscow TRUDY ORDENA LENINA FIZICHESKOGO INSTITUTA IMENI P.N. LEBEDEVA  
 AKADEMII NAUK SSSR: INZHEKTSIONNYYE LAZERY in Russian Vol 141, 1983  
 pp 62-88

BOGATOV, A. P., YELISEYEV, P. G., OKHOTNIKOV, O. G., PAK, G. T.,  
 PASHKO, S. A., RAKHVAL'SKIY, M. P. and KHAYRETDINOV, K. A.

[Abstract] Development of reliable CW stripe-geometry heterostructure lasers that operate at room temperature and efficient total internal reflection holographic selectors has made it possible to study the optical heterodyning of the emissions of two independent injection lasers. Double heterostructure AlGaAs/GaAs laser diodes with an active region

0.4 micrometers thick and a stripe geometry contact 10 micrometers wide, without any special coatings on the output faces of the diodes, having typical threshold currents of 120 to 150 mA were used in this study of effective single frequency lasing and the accompanying phenomena in such lasers. Tunable single mode lasing was achieved in an injection laser with an external dispersive cavity with output powers of up to 9 mW. A total internal reflection holographic selector with a line density of  $3,100 \text{ mm}^{-1}$  was used as the external cavity. This cavity has a spectral selectivity 4 to 10 times greater than a plane reflective diffraction grating. Despite the optical inhomogeneity of the gelatin layer in which the grating was recorded, which kept the holographic selection efficiency below the theoretically attainable 100% for large diffraction angles of about  $80^\circ$ , such a selector is the optimal dispersive cavity at the present time. The intracavity collimator was an objective lens with an aperture of 0.8 mm and a focal length of 6.3 mm; the optical length of the external cavity was 30 cm. A detailed theoretical analysis of the spectral tuning of the laser is followed by the experimental data on bistable lasing and spectral tuning. Spectral bistability is explained and the radio frequency spectra of the laser emission intensity fluctuations as well as the properties of the beat frequency modes are also studied in detail. The phenomenon of "autostabilization" of the single frequency mode is found to be the result of parametric interaction of the modes; the use of this effect substantially facilitates the resolution of the problem of single frequency high power emission for nonlinear spectroscopy, holography, coherent optical communications and other applications. The authors are deeply grateful for the fruitful cooperation and considerable assistance of Kh.-Yu. Bakhert, V. Yu. Bazhenov, Yu. V. Gurov, A. Ye Drakin, M. S. Soskin and V. B. Taranenko. Figures 20, references 40: 22 Russian, 18 Western.  
[27-8225]

UDC 621.378.325

#### INJECTION LASERS BASED ON AlGaAsSb/GaSb AND InGaAsSb/GaSb HETEROSTRUCTURES

Moscow TRUDY ORDENA LENINA FIZICHESKOGO INSTITUTA IMENI P.N. LEBEDEVA  
AKADEMII NAUK SSSR: INZHEKTSIONNYYE LAZERY in Russian Vol 141, 1983  
pp 46-61

DOLGINOV, L. M., DRAKIN, A. Ye., DRUSHININA, L. V., YELISEYEV, P. G.,  
MIL'VIDSKIY, M. G., SVERDLOV, B. N. and SKRIPKIN, V. A.

[Abstract] The FIAN [Physics Institute imeni P. N. Lebedev of the USSR Academy of Sciences] in conjunction with the GIREDMET [State Scientific Research and Planning Institute of the Rare Metals Industry] studied isoperiodic AlGaAsSb/GaSb and InGaSb/GaSb systems in order to optimize heterostructure lasers based on these materials. Liquid phase epitaxy was used to produce double heterostructures of AlGaAsSb and InGaAsSb

on GaSb n-substrates doped with Te or undoped p-substrates. The geometry, production and performance of these structures are detailed. The use of AlGaAsSb/GaSb as the basis for a buried stripe double heterostructure laser makes it possible to obtain very low threshold current levels at wavelengths of 1.72 to 1.78 micrometers at room temperature. The threshold currents typically varied between 0.53 and 1.00 A. Linear current-power characteristics are obtained for these lasers at 300 K with the greatest peak power being 1W with a pulse width of 0.1 microsecond. The electroluminescence spectra of double heterostructure lasers are studied experimentally and theoretically in this paper. Calculated and experimental values of the fundamental mode beamwidth of AlGaAsSb/GaSb lasers are summarized in tabular form for wavelengths of 1,660 to 1,770 nm showing good agreement between experiment and theory. Both the experimental data and interpolations demonstrate that there is considerable electron limiting in  $\text{Al}_x\text{Ga}_{1-x}\text{As}_y\text{Sb}_{1-y}/\text{Al}_{x'}\text{As}_{y'}\text{Sb}_{1-y'}$  heterostructures when  $0 < x < 0.1$  and  $0.2 < x' < 0.4$ . The minimum threshold current is estimated as  $1 \text{ kA/cm}^2$  at wavelengths of 1.75 to 1.78 micrometers. A unique feature of  $\text{A}^{3\text{B}5}$  semiconductors revealed in the study of InGaAsSb/GaSb is that the narrow band layer has an index of refraction in a wide range of variation in the forbidden band which is less than the index of refraction of the broad band layers. The "antiwaveguide" anomaly in this system can also be useful in the production of new types of laser heterostructures, particularly to increase the cross section of single mode structures, produce lasing in nonwaveguide diode modes as well as in integrated optical devices for efficient repumping radiation into a waveguide based on a material with a wider forbidden band and a large index of refraction. Figures 14, tables 3, references 22: 11 Russian, 11 Western.

[27-8225]

UDC 621.378.325

#### HETEROSTRUCTURE INJECTION LASERS BASED ON GaInPAs/InP

Moscow TRUDY ORDENA LENINA FIZICHESKOGO INSTITUTA IMENI P.N. LEBEDEVA  
 AKADEMII NAUK SSSR: INZHEKTSIONNYE LAZERY in Russian Vol 141, 1983  
 pp 18-45

BEZOTOSNYY, V. V., BOGATOV, A. P., DOLGINOV, L. M., DRAKIN, A. Ye.,  
 YELISEYEV, P. G., MIL'VIDSKIY, M. G., SVERDLOV, B. N. and SHEVCHENKO, Ye. G.

[Abstract] Heterostructure laser research at the FIAN [Physics Institute imeni P. N. Lebedev of the USSR Academy of Sciences) and GIREDMET [State Scientific Research and Planning Institute of the Rare Metals Industry] has been directed toward the design of an optimal laser for fiber optics communications. These two institutes have together produced embedded-stripe heterostructure GaInPAs/InP lasers capable of CW operation at room temperature with threshold currents of 25 to 75 mA at 1.25 to 1.32 micrometers. Such lasers have linear current-power characteristics, narrow-band single frequency emissions and a service life of more than 3,000 hours

at 300 K. This paper is a detailed discussion of the results of studies of the properties of a solid solution of GaInPAs isoperiodic with InP and the heterostructure lasers based on it. Procedural aspects of the growth of these heterostructures using liquid phase epitaxy are treated in some detail along with the emission characteristics and performance of GaInPAs/InP lasers. The behavior of the threshold current in such lasers is studied as a function of temperature. The interpolation calculations in the first section of this paper predict the fundamental properties of a solid solution of GaInPAs, allowing the optimization of these injection lasers. The best reproducible results are obtained by growing the structures from a solid solution of the supercooled melt at a constant temperature; this technique was used to grow defect-free heterostructures throughout the entire range of variation in the compositions of the isoperiodic solid solution. Injection lasers with room temperature emission wavelengths of from 1.06 to 1.67 micrometers were constructed with these heterostructures. The experimental and theoretical study of the new embedded-strip lasers clearly demonstrates that such lasers operating at 1.3 micrometers are the most promising for applications in fiber optics communications systems. Figures 24, tables 3, references 31: 13 Russian, 18 Western. [27-8225]

UDC 621.378

#### INJECTION LASER RESEARCH AT PHYSICS INSTITUTE OF USSR ACADEMY OF SCIENCES

Moscow TRUDY ORDENA LENINA FIZICHESKOGO INSTITUTA IMENI P.N. LEBEDEV  
 AKADEMII NAUK SSSR: INZHEKTSIONNYYE LAZERY in Russian Vol 141, 1983  
 pp 3-17

YELISEYEV, P. G.

[Abstract] Fundamental research in solid state injection lasers has been ongoing at the FIAN [Physics Institute imeni P. N. Lebedev of the USSR Academy of Sciences] for over 20 years. Such problems as single mode and single frequency operation, peakless operating modes, CW operation at room temperature for wavelengths of 0.8 to 0.9 and 1.1 to 1.3 micrometers, the service life of heterostructure lasers, etc., have been successfully resolved during this period. This review covers the history of injection laser research at the FIAN, briefly surveying the following: 1) injection laser theory; 2) major areas of experimental studies; 3) heterostructure lasers and their service life; 4) new heterostructure lasers (e.g., buried-stripe double heterostructures); 5) streamer lasers; 6) single frequency and tunable injection lasers; 7) applications. The scope of this general review precludes any detailed treatment of new device performance or design. The author is grateful to his colleagues at the FIAN, in particular Yu. M. Popov, A. P. Shotov and A. N. Pechenov for help in compiling the review. References 127: 120 Russian, 7 Western. [27-8225]



## NUMERICAL PERFORMANCE ANALYSIS OF LASER ON COMPLEX COMPOUNDS OF RARE EARTH ELEMENTS IN SOLUTION WITH MONOPULSE PUMPING

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 29, No 6, Dec 83  
(manuscript received 17 Aug 82) pp 945-953

MALASHKEVICH, G. Ye. and KUZNETSOVA, V. V.

[Abstract] The performance of a laser on substances with transfer of electron excitation energy from the sensitizing additive to the emitting additive is analyzed on the basis of a general model of the energy band structure in a donor-acceptor system with organic ligands as donor and europium ion as acceptor, with monopulse pumping. Considering that the probabilities of interconversion and breakup of the triplet state in the donor as well as the probability of intramolecular excitation transfer to the rare earth ion are all several orders of magnitude higher than the probability of radioactive transitions in the acceptor, the corresponding system of equations has been solved numerically for three basically different modes of excitation: 1) weak excitation with the population of luminescence levels much smaller than the number of  $\text{Eu}^{3+}$  ions; 2) intermediate excitation intensity yielding a population of luminescence levels comparable with the population of the ground state; 3) strong excitation with the population of luminescence levels exceeding the population of the ground state. The complete pumping and emission cycle includes deactivation of the acceptor from its upper state (8), most likely through quenching by ligands with attendant energy transfer back from acceptor to donor either by the exchange mechanism or by the induction-resonance mechanism and generally by both mechanisms. Calculations have yielded the population buildup and decay transients at the triplet  $n_3$  level in ligands and at the  $^5\text{D}_1$  level in  $\text{Eu}^{3+}$ , the pressure dependence of the quantum yield of transitions from excitation level in ligands to luminescence level in  $\text{Eu}^{3+}$ , and the transients of laser radiation intensity along with those of population change at triplet level and initial laser level in a laser on solution of europium chelate. The results reveal that the quantum yield of luminescence from this complex compound decreases with increase of the pumping power and that emission at the  $^5\text{D}_0 \rightarrow ^7\text{F}_2$  transition occurs after the end of the pumping monopulse. Figures 4, references 10: 9 Russian, 1 Western.  
[159-2415]

## LASER ON COPPER AND GOLD VAPORS WITH SPACE DIVERSITY MEDIA

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 29, No 6, Dec 83  
(manuscript received 9 Sep 82) pp 939-944

YEVTUSHENKO, G. S., KIRILOV, A. Ye., POLUNIN, Yu. P. SOLDATOV, A. N. and  
FEDOROV, V. F.

[Abstract] Energy and time characteristics of stimulated radiation in copper and gold vapors with simultaneously self-limited transitions were studied experimentally under conditions designed to favor efficient emission. These conditions included similar mechanisms of population inversion in both lasing media, nearly equal parameters of the respective pumping pulses and equal discharge characteristics (same kind and same pressure of buffer gas, equal concentrations of normal and excited atoms respectively, equal electron concentrations and equal electron temperatures), transparency of the gaseous plasma for radiation at atomic and ionic emission lines of both metals, and high gain for attainment of emission in a nonselective resonator with the active space for each metal much shorter than the distance between resonator mirrors. Both active media were arranged in two ways, either with independent heating of each or with space diversity utilizing the different heat conduction characteristics of thermal insulation layers (two different fractions of  $ZrO_2$  powder). In the latter case the optimum arrangement was placing the gold zone on the cathode side, with the highest electric field intensity at the instant of population inversion. The high-temperature channel was BeO tubes, the inert gas (neon) prevented active mixing of the two metals and their migration to cold regions of the discharge tube. The temperature drop in copper and gold zones could be varied from  $\pm 50$  to 200 K, the pressure of the inert gas could be varied from 0.5 to 20 kPa. The instrumentation included an opaque mirror before the gas discharge tube, a set of plane-parallel plates behind the latter, a bandpass filter, an MDR-3 monochromator, two IMO-2 wattmeters, a prism followed by an FK-9 coaxial photocell, and an S7-8 2-channel oscilloscope. The integral radiation spectrum of Cu+Au+Ne plasma and the energy distribution between peaks reveal an attenuation of the Ne lines as steady-state emission is reached. Oscillograms of voltage pulses and transients of spontaneous-emission intensity at individual spectral lines corresponding to the two modes of media diversity and recorded at various heating levels indicate the feasibility of producing a high-efficiency (0.3-0.5%) high-power (0.5-4 W) multifrequency laser by optimizing the active volumes and the space diversity as well as other parameters of the discharge system. Additional data were obtained with Ba+Pb+Ne and Cu+Ba+Pb+Ne media. The authors thank A. I. Yelgin for assistance in the experiments and V. F. Yelayev for helpful discussion of the results. Figures 5, references 13: 9 Russian, 4 Western.

[159-2415]

## EFFICIENCY OF LASING DYE MEDIA IN PUMPING HIGH-POWER RADIATION WITH NANO-SECOND PULSES

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 29, No 6, Dec 83  
(manuscript received 22 Nov 82) pp 934-938

BATISHCHE, S. A., GANZHA, V. A., MALEVICH, N. A., MOSTOVNIKOV, V. A.,  
PERLOV, D. I. and SHIFRIN, V. P.

[Abstract] Various lasing dye media are available for conversion of radiation pulses from solid-state or gas lasers into near-ultraviolet, visible, or near-infrared radiation, but their pumping efficiency drops appreciable from 30-65% as the output power is increased. The causes of this drop were investigated in an experimental study with several dye solutions. Rhodamine and oxazine solutions were excited by second-harmonic emission pulses of 50 ns duration and 5 J maximum energy from a neodymium-glass laser, polymethyne solutions were excited by second-harmonic emission pulses of 20 ns duration and 5 J maximum energy from a ruby laser. The dye lasers operated without resonator mirrors, but a diaphragm with aperture equal to the cross section of the pumping beam was placed between the active medium and the photoreceiver. The dependence of the emission efficiency on the pumping power density and on the width of the excitation zone, also of the gain and the transmission coefficient on the pumping power density was determined for rhodamines 6G and 4S, oxazine 17 in ethanol, and polymethyne No. 5364. The results reveal peaking of the efficiency and the output energy at an optimum power pumping density and at an optimum width of the excitation zone. At output power levels higher than optimum the efficiency decreases because of increasing superluminescence. With an excitation zone wider than optimum the efficiency and the output energy are higher, also the spot geometry is more favorable, when the pumping radiation is polarized by an air bubble that stimulates concurrent emission with the participation of dye molecules having a dipole moment parallel to the air-bubble interface. Figures 4, references 14 Russian.

[159-2415]

## OPTICAL PROPERTIES OF LASER EROSION FLARES IN PLASMA

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 29, No 6, Dec 83  
(manuscript received 10 Sep 82) pp 930-934

GONCHAROV, V. K., MIN'KO, L. Ya. and NASONOV, V. I.

[Abstract] An experimental study was made of plasma flares caused by eroding laser radiation, for the purpose of determining the transient

characteristics and the space profiles of their optical properties. Radiation from a neodymium laser ( $1.06 \mu\text{m}$ ) operating in the free emission mode was focused normally on a target of VFT-S glass-textolite with a power density of  $1.2 \cdot 10^6 \text{ W/cm}^2$  for a duration of  $700 \mu\text{s}$ . The plasma flare produced by erosion of the target and propagating against the laser beam was probed with regular radiation pulses at a power density of  $10^4 \text{ W/cm}^2$  from a ruby laser ( $0.69 \mu\text{m}$ ). The probing radiation was synchronized by means of an electric discharge trigger with the erosive radiation as the latter was impinging on and passing through a plasma flare. The intensity measuring and recording instruments had been calibrated on radiation diffusely scattered by a specimen of MS-14 opal glass at the center of an integrating sphere. The evolution of the transmission, scattering, and absorption coefficients at various heights above the target, as well as the profiles of these coefficients, also of the absorptive index along the erosive plasma flare, were determined from measurements, oscillograms and photographs. The results reveal large particles of the target material (with geometric dimensions larger than the radiation wavelength) within the probed flare zone, indicating almost equal scattering coefficients and almost equal absorption coefficients at both eroding and probing laser wavelengths. They also reveal direct shielding of the eroding laser radiation by erosion products, most effectively at the target surface. Figures 4, references 5 Russian. [159-2415]

UDC 621.378.325

#### POWERFUL TWO-WAVE $\text{CO}_2$ LASER

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 53, No 12, Dec 83  
(manuscript received 12 Feb 83) pp 2424-2425

BURTSEV, V. A., VASILEVSKIY, M. A., KOZYUCHENOK, S. S., RODICHKIN, V. A., ROYFE, I. M., STEKOL'NIKOV, B. A., TOMASHEVICH, V. P. and AHANSKIY, V. F.

[Abstract] A powerful  $\text{CO}_2$  laser operating at  $10.6$  and  $9.6 \mu\text{m}$  is developed for fusion research. The laser incorporates two modules, each with its own power source and each containing a discharge chamber and an ionization device consisting of an electron gun that produces a flat beam entering the discharge chamber through a special opening covered by aluminum foil  $30 \mu\text{m}$  thick. The specific energy contribution and specific energy output are given as a function of the reduced electrical field intensity in the discharge chamber. The maximum energy contribution is  $0.6 \text{ J/cm}^3 \cdot \text{atm}$ . No breakdown of the discharge interval has been observed. The radiation intensity of both wavelengths is identical at a pressure of  $4.2 \text{ mm Hg}$ , and the peak power produced is approximately  $5.5 \text{ GW}$ . Figures 2, references 4: 3 Russian, 1 Western. [152-6900]

## TWO-FREQUENCY TUNABLE LASER

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 12, Dec 83  
(manuscript received 3 Mar 82) pp 2394-2396

ARUMYUNYAN, V. M., DZHOTYAN, G. P., KARMENYAN, A. V. and MELIKSEMYAN, T. E.

[Abstract] A two-frequency tunable dye laser with continuous frequency tuning based on a thin layer of active substance placed between two passive media is proposed. The physical bases of the proposed device are described. Figure 1, references 11: 6 Russian, 5 Western.  
[152-6900]

## MASS REFLECTRON FOR INVESTIGATING PROCESSES UNDERLYING INTERACTION OF LASER RADIATION WITH MOLECULES IN SUPERSONIC GAS JETS

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 10, Oct 83  
(manuscript received 26 Jan 83) pp 2039-2044

IVANOV, M. A., KOZLOV, B. N., MAMYRIN, B. A., SHMIKK, D. V. and SHCHEBELIN, V. G.

[Abstract] A mass reflectron is described that incorporates a fundamentally new ion source design and provides the capability of evacuating the source cavity and analyzer cavity separately. The electronics modules have superior protection against powerful induced pulse effects, and a new circuit for synchronizing all pulse devices is employed. Described in detail are the ion source, the ion reflector and detector, the electronic devices and the synchronization procedures. The findings from studies employing the new device are presented separately. Figures 3, references 10: 5 Russian, 5 Western.  
[156-6900]

INFLUENCE OF INSTABILITY OF AMPLITUDE-PHASE DISTRIBUTIONS OF LASER BEAMS  
ON QUALITY OF HOLOGRAPHIC INTERFERENCE BANDS DURING DIFFUSE ILLUMINATION  
OF OBJECTS

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 10, Oct 83  
(manuscript received Jul 82) pp 1995-2003

BEREZINSKAYA, A. M., STASEL'KO, D. I. and CHURAYEV, A. L.

[Abstract] A theoretical and experimental assessment of the acceptable variation in the amplitude-phase distributions of laser beams is made as a function of the nature of the beams and the conditions under which the object is illuminated. The influence of amplitude-phase distribution variation on the quality of the holographic interference band pattern is analyzed theoretically for single and double scattering of the object beam assuming linear recording of the amplitude hologram and single-mode lasing. An experimental setup incorporating an LG-38 helium-neon laser is employed to test the theoretical results experimentally. Criteria are formulated for the necessary stability of laser beam parameters in holographic interferometry employing scattering surfaces. Figures 3, references 10 Russian.  
[156-6900]

DUAL HETEROLASERS IN InGaAsP/InP SYSTEM OBTAINED BY IMPLANTATION OF OXYGEN  
IONS

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 10, Oct 83  
(manuscript received 26 Aug 82) pp 1973-1978

GORELENOK, A. T., KOLYSHKIN, V. I. and TARASOV, I. S.

[Abstract] This study provides a detailed investigation of the effect of deep high energy oxygen ion implantation on the threshold, power and waveguide properties of InGaAsP/InP heterolasers. The smallest threshold current values are obtained for radiation bases of  $10^{14}$ - $3 \cdot 10^{14}$  ion/cm<sup>2</sup> when the depth of penetration of the oxygen ions into the dual heterostructures is close to the thickness of the upper emitter. The degree of current limiting is estimated on the basis of the current-voltage characteristics of the irradiated sections of the dual heterostructure, and the spectral composition of the radiation is investigated as a function of the depth of ion penetration and stripline contact width. Figures 6, references 17: 7 Russian, 10 Western.  
[156-6900]

PROBLEM OF KINETICS OF LASERS WITH UNSTABLE RESONATORS EMPLOYING MEDIA  
WITH SHORT INVERSION TIMES

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 10, Oct 83  
(manuscript received 15 Feb 83) pp 1959-1965

ANAN'YEV, Yu. A. and ANIKICHEV, S. G.

[Abstract] Calculations are performed for the typical case of a pulsed laser employing a medium with a "self-limiting" transition in which the lasing pulse length is limited chiefly by repopulation of the lower working level, which takes place in metal vapor lasers. The angular and energy characteristics of the output radiation are analyzed as a function of resonator parameters, and the experimentally observed effect of self-modulation of radiation is explained. Figures 4, references 11 Russian. [156-6900]

EVADING ELECTRON CURRENT EFFECT AND FORMATION OF SPATIAL STRUCTURES IN PLASMA  
OF EXCIMER LASERS

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 10, Oct 83  
(manuscript received 21 Feb 83 after revision) pp 1952-1958

DRESVYANNIKOV, V. G. and FISUN, O. I.

[Abstract] A nonlinear theory of the phenomenon of evading electron current is constructed with allowance for unsteadiness of the working conditions of the plasma formation of lasers, which is extremely significant in this case. The uniform state of the plasma is demonstrated to be unstable with respect to pinching leading to arc formation. The findings provide a partial explanation of the pitting of electrodes observed in experiments in the evading electron current mode that is not explicitly associated with variation in the density of neutral particles as a consequence of arc formation in accordance with the mechanism described. Figures 4, references 14: 3 Russian, 11 Western. [156-6900]

## ADAPTIVE POWER OPTICS ELEMENTS BASED ON OPEN POROUS STRUCTURES

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian  
Vol 47, No 10, Oct 83 pp 2050-2956

APOLLONOV, V. V., PROKHOROV, A. M., KHOMICH, V. Yu. and CHETKIN, S. A.

[Abstract] The findings of a study of ways for creating phase correctors for the beam circuit of laser systems based on cooled power optic elements are presented. The form of the reflecting surface is controlled by deforming a porous heat exchanger. A model of an adaptive cooled laser mirror based on a porous structure is constructed. The problem of matching the shape of the reflecting surface to the basic types of aberrations is solved, and basic expressions are derived which describe the optimum phase-matching algorithm. Figures 4, references 4:

3 Russian, 1 Western.

[162-6900]

EFFECTIVENESS OF METAL TREATMENT FOR DIFFERENT CONDITIONS OF INTERACTION OF CO<sub>2</sub> LASER RADIATION WITH SURFACE

Moscow POVERKHNOST': FIZIKA, KHIMIYA, MEKHANIKA in Russian No 11, Nov 83  
(manuscript received 7 May 82) pp 123-130

LOPOTA, V. A., GORNYI, S. G., IVANOVA, I. N. and SHTERNIN, L. A.,  
Leningrad Polytechnical Institute, All-Union Scientific Research, Design,  
Planning and Technological Institute of electric Welding Equipment, Leningrad

[Abstract] An investigation is made of the effectiveness of interaction of CO<sub>2</sub> laser radiation with metal when the beam axis deviates from the normal to the surface being treated for the following cases: heating without melting of the surface, heating with surface melting without vaporization of metal, heating with deep melting typical of welding processes where a vapor-gas channel is formed in the melting zone due to intense vaporization. Relations are found for heating efficiency, thermal efficiency of the welding process as a function of the angle of incidence of the beam on the metal surface, surface roughness, and the use of welding fluxes with additives of metal powders and graphite. It is found that vapor over the metal surface has a considerable effect on absorption of laser radiation. The efficiency of metal heating without surface melting increases with increasing angle of beam incidence from 0 to 60°. In "backward angle" welding, the depth of melting and thermal efficiency show extremum dependence on the angle of beam incidence, the maximum



occurring at angles of 7-10°. In preparing the surfaces of components for treatment by CO<sub>2</sub> laser, microroughness must be kept below 2-3 µm. The use of welding fluxes considerably increases the efficiency of heating metals without surface melting, and does not change the effective or thermal efficiency of the welding process, while protecting the surface of welds from oxidation. Figures 7, references 11: 9 Russian, 2 Western. [130-6610]

#### ANOMALIES IN FREQUENCY CHARACTERISTICS OF SOLID-STATE RING LASER

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 1, 12 Jan 84 (manuscript received 5 Aug 83) pp 20-25

DOTSENKO, A. V., LARIONTSEV, Ye. G. and SHELAYEV, A. N., Scientific Research Institute of Nuclear Physics, Moscow State University imeni M. V. Lomonosov

[Abstract] The paper is a theoretical analysis and experimental study of the frequency characteristics of a rotating solid-state (YAG:Nd<sup>3+</sup>) ring laser with attenuation of competing interaction of opposed waves due to additional nonlinear losses. It is found that the frequency responses of solid-state ring lasers are considerably different from those of gas ring lasers as a result of the slow relaxation of inverse population in solid-state ring lasers. It is shown that strong phase nonreciprocity arises in the solid-state laser due to shift of the frequencies of opposed waves upon reflection from a moving grating of inverse population formed as a consequence of spatially inhomogeneous burnout in the field of the opposed waves. The magnitude of the phase nonreciprocity depends on the ratio of rates of relaxation of the field and the inverse population. The results of the research show a number of unusual anomalous peculiarities in frequency characteristics of rotating solid-state ring lasers with uniformly broadened luminescence line of the active substance upon attenuation of competition of opposed wave. In particular, when consideration is given to slowness of relaxation of inverse population, it is found that a frequency difference of opposed waves can be obtained that is opposite in sign to the frequency difference of the cavity caused by rotation. With a change in detuning between the lines of the amplifying and absorbing media, it is shown that there may be an appreciable change in the absolute value of the frequency difference of opposed waves in a rotating solid-state ring laser. Figures 2, references 3 Russian. [121-6610]

# SOLID-STATE LED-PUMPED YAG:Nd<sup>3+</sup> RING LASER

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 10, No 1,  
12 Jan 84 (manuscript received 26 Jul 83) pp 44-49

BELOZEROV, S. A., KORNIYENKO, L. S., KRAVTSOV, N. V., KURATEV, I. I.,  
RUSAKOV, S. I., STEL'MAKH, M. F., SHELAYEV, A. A. and SHELAYEV, A. N.

[Abstract] The article is a report on attainment of stimulated emission in a YAG:Nd<sup>3+</sup> solid-state ring laser ( $\lambda = 1.06 \mu\text{m}$ ) with both cw and pulsed pumping by light-emitting diodes. The YAG:Nd<sup>3+</sup> crystal was 1.5 mm in diameter and 20 mm long with Brewster faces. The laser was made as a monoblock in which channels were drilled for the laser beam. Total losses on the mirrors did not exceed 0.2%. Cavity perimeter was 22 cm. Pumping was by two lines of LEDs based on epitaxial heterostructure  $\text{Al}_x\text{Ga}_{1-x}\text{As}$ . In the pulsed pumping mode maximum pulse duration was 8 ms, and maximum recurrence rate was 100 Hz. The threshold pumping current in the pulsed mode was about 1.1 A with prf of 10 Hz, pulse duration of 0.5 ms and temperature of 300 K. Maximum admissible current in this mode is 6 A. In cw pumping, the LED lines were fed by a stabilized DC source at voltage of about 40 V. Threshold pumping current was about 1.5 A, i.e., the threshold power was about 60 W. The optimum maximum current in the cw mode was about 2.0 A. Emission power was a near-linear function of current through the LEDs in either pumping mode. It was experimentally demonstrated that a rotating ring laser can produce stable beats with both cw and pulsed LED pumping. It should be possible to use self-switching modes to measure non-reciprocal effects. Figures 2, references 5 Russian.  
[121-6610]

UDC 621.373.826

## INVESTIGATION OF INFLUENCE OF INTRACAVITY ABSORPTION ON EMISSION SPECTRUM OF ELECTRIC-DISCHARGE XeCl LASER

Minsk DOKLADY AKADEMII NAUK BSSR in Russian Vol 27, No 10, Oct 83  
(manuscript received 9 Feb 83) pp 885-888

BURAKOV, V. S., associate member, BSSR Academy of Sciences, BOKHONOV, A. F. and TITARCHUK, V. A., Institute of Physics, BSSR Academy of Sciences

[Abstract] An experimental investigation is made of the behavior of spectral and energy characteristics of an electric-discharge XeCl exciplex laser as a function of mixture composition, supply voltage and total pressure. Consideration is also given to the effect that the plasma inside the optical cavity has on the spectral characteristics of the laser. The discharge chamber of the laser was made of polymethyl methacrylate, and had a capacity of 15 liters. Supply was from a thyatron-fired LC circuit. Spark gaps provided ultraviolet preionization of the active medium. Energy

of emission was measured by the IMO-2I instrument, and the spectral characteristics were registered by a diffraction spectrograph with inverse linear dispersion of 0.2 nm/mm. Pulse duration was measured by an FK-2 coaxial photocell. The results show a maximum pulse power of laser emission of 4 MW integrated over the spectrum. Spectral power on the 307.96 nm line can be enhanced by using an aluminum-enriched plasma in the optical cavity to take advantage of selective absorption on the line center at 308.215 nm. Figures 2, references 5: 3 Russian, 2 Western.  
[105-6610]

UDC 621.375.8

#### OPTIMIZING cw CO<sub>2</sub> LASERS WITH RESPECT TO OUTPUT POWER IN DIFFERENT BANDS

Minsk DOKLADY AKADEMII NAUK BSSR in Russian Vol 27, No 10, Oct 83  
(manuscript received 17 Jan 83) pp 893-896

PETUKHOV, V. O., Institute of Physics. BSSR Academy of Sciences

[Abstract] The author considers the problem of optimizing output power of cw CO<sub>2</sub> lasers in bands that have just recently begun to be used in special applications: 00<sup>0</sup>1-10<sup>0</sup>0, 00<sup>0</sup>2-10<sup>0</sup>1 and 01<sup>1</sup>1-11<sup>1</sup>0. It is shown how this can be done by using information on the vibrational temperatures of excited CO<sub>2</sub> molecules in the active medium of a cw laser. The analysis is based on a vibrational temperature approximation in which the output lasing power for any of these bands depends on vibrational temperatures of asymmetric, deformation and symmetric modes of the CO<sub>2</sub> molecule, as well as on the translational temperature. The much greater energy capacity of the symmetric and deformation modes as compared with the asymmetric mode, constant heat transfer from the lower laser levels, and also the low efficiency of conversion of the energy invested in the discharge to lasing energy are taken as indications that the excited active medium in the lasing mode differs from the state without lasing only in the temperature of asymmetric vibration. The proposed method of optimization is confirmed by experiments. The technique can be used to optimize the output parameters of radiation as a function of discharge current and storage factor of the cavity for the conventional 00<sup>0</sup>1-10<sup>0</sup>0 and 00<sup>0</sup>1-02<sup>0</sup>0 bands as well. Figures 2, references 8: 4 Russian, 4 Western.  
[105-6610]

RANDOM PROCESSES AND MAGNETOHYDRODYNAMIC TURBULENCE

Riga MAGNITNAYA GIDRODINAMIKA in Russian No 4, Oct-Dec 83  
(manuscript received 27 Jan 83) pp 87-93

BERSHADSKIY, A. G.

[Abstract] Magnetohydrodynamic turbulence is analyzed as a random process. In the case of three-dimensional turbulence with a continuous spectrum it is demonstrated that the trajectories of liquid particles are nondifferentiable. The proof is based on using the Poisson instability according to Poincaré and considering a statistically steady turbulent flow within a bounded region, with S-intervals of the velocity field along the time axis. A subsequent analysis of turbulent MHD flow dynamics yields the stochastic analog of conventional MED equations. These reveal that the principal stabilizer is action of the magnetic field not on the average flow but directly on the turbulent noise. A relation between small fluctuations and the average flow is established on the basis of the perturbation theory. This relation for exponential relaxation decay of turbulence is comparable with the Prandl hypothesis. A practical application is suppression of turbulence by a uniform magnetic field perpendicular to the solid walls of the MHD channel. The author thanks A. B. Kapusta, S. P. Sosnitskiy and E. V. Shcherbinin for stimulating discussions. References 10 Russian.  
[182-2415]

ANGULAR DISTRIBUTION OF CHARGED-PARTICLE FLUXES EMANATING FROM THICK TARGET BOMBARDED BY PHOTON BEAMS,  $\alpha$ -PARTICLE BEAMS AND  $^{12}\text{C}$ -NUCLEI BEAMS WITH 3.65 GeV/NUCLEON ENERGY

Moscow ATOMNAYA ENERGIYA in Russian Vol 55, No 6, Dec 83  
(manuscript received 9 Jun 83) pp 412-414

ALEYNIKOV, V. Ye. and TIMOSHENKO, G. N.

[Abstract] The angular distribution of charged-particle fluxes emanating from a thick target upon bombardment of the latter by relativistic nuclei is analyzed on the basis of measurements made in the slow-extraction channel of the synchrophasotron at the High Energy Laboratory (Joint Institute of Nuclear Research). A target was bombarded with 3.65 GeV/Nucleon proton beams,  $\alpha$ -particle beams, and  $^{12}\text{C}$ -nuclei beams. This target was a copper cylinder 100 mm in diameter and 130 mm thick in the beam path at the focus. The incident beams were monitored by a sensitive ionization chamber in the beam path at the exit from the ion guide, also by two counters in a telescope aimed normally to the incident beam. The yield of secondary charged particles emanating from the other side of the target at angles ranging from 10-105° was measured by three counters in a telescope with 0.6° angle resolution and p,  $\pi$ , d, t, and  $\alpha$ -particle energy thresholds of 42, 18, 57, 68, and 168 MeV respectively. The results of measurements, normalized to a single respective incident particle, have been evaluated by the method of least squares. This evaluation yields in each case a charged particle flux that decreases, in an approximate model, exponentially with increasing angle from the direction of the incident beam, at least over the 25-90° range of exit angles. Deviations from this exponential model are attributable to interaction of target and striking nuclei, absorption being determined not only by the beam intensity but also by the particle energy. The authors thank M. M. Komochkov for helpful discussions and V. P. Bamblevskiy for providing data on the activation-type detectors used in this study. Figures 2, references 2 Russian.  
[203-2415]

## PROOF OF METHOD OF PULSED NEUTRON LOGGING DURING RELEASE OF STRONG ABSORBERS

Moscow ATOMNAYA ENERGIYA in Russian Vol 55, No 6, Dec 83  
(manuscript received 16 May 83) pp 407-409

GALIMBEKOV, D. K., ILAMANOVA, I. T., LUKHMINSKIY, B. Ye.  
and PSHENICHNYUK, A. I.

[Abstract] For the purpose of theoretically proving the method of ore logging with neutron pulses, the space-time distribution of thermal neutrons and the capture gamma emission have been calculated numerically by a Monte-Carlo method. From the results obtained for the geometry of a hydrogen-filled corehole, a sandstone bed containing cinnabar, this mercury ore being a strong neutron absorber, and for a 14.1 MeV neutron pulse generator, one can estimate the length of transients corresponding to local multiplicity as well as the sensitivity to changes in corehole diameter and in instrument location. Such estimates are made for instruments with 5-30 cm long probes (5-30 cm thick shields between target and detector) in coreholes 59-76 cm in diameter. The evaluation of data takes account of the spectral characteristics of the neutron field determined by the mineral content of a rock as well as the dependence of the capture gamma emission flux on the volume fraction of ore in the rockbed and on the energy of the incident probing neutron flux. The results validate this method with short delay time not exceeding 25  $\mu$ s in recording neutron flux pulses of 150, 350, and 800  $\mu$ s duration, in the case of mercury ores. Figures 2, references 4 Russian.  
[203-2415]

UDC 621.039.546

## COMPOSITION OF GASEOUS PHASE AND BEHAVIOR OF XENON AND KRYPTON IN IRRADIATED FUEL ELEMENTS OF BOR-60 REACTOR

Moscow ATOMNAYA ENERGIYA in Russian Vol 55, No 6, Dec 83  
(manuscript received 18 Apr 83) pp 405-407

KIRILLOVICH, A. P., PIMONOV, Yu. I., LAVRINOVICH, Yu. G. and BOYKO, O. S.

[Abstract] The gaseous phase in irradiated fuel elements, consisting of inert fillers, fission products, and desorbates, influences not only the reactor performance and safety but also the fuel regeneration. A method of sampling the gaseous phase for subsequent quantitative chemical and isotope analysis by mass-spectrometry has been developed, the specific purpose being to evaluate the kinetics of Xe and Kr release as well as their isotope content during meltdown of the shell in a BOR-60 MW reactor. The method involves determining the relative sensitivities to various gases

and the pressure range of sampling within which these sensitivities remain constant. It is most efficient when the ion source for the mass-spectrometer operates within the range of maximum sensitivity to analyzed gas components, usually to hydrogen. The equipment includes a special-purpose gas admission system consisting of a sampler, a sorption trap, a vacuum pump, a gas cylinder, a set of sampling vessels with valves, a mixer with valves, and a manometer. The sampler consists of a needle for puncturing a fuel element, a furnace for melting down a shell and releasing the gases from underneath, a filter, and an absorption pile. The method and equipment were tested with an MI-1201 mass-spectrometer for determination of  $H_2$ , He, Ar,  $N_2$ ,  $O_2$ , CO,  $CO_2$  as well as of Xe and Kr in amounts over the 0.01-100% range. Measurements were made for  $UO_2$  fuel (90%  $^{235}U$ -enriched) and 80%  $UO_2$  + 20%  $PuO_2$  fuel at temperatures up to 700°C. The results are compared with norms and standard data. Figures 2, tables 5, references 6: 5 Russian, 1 Western.  
[203-2415]

UDC 533.95

CONDITIONS FOR DEVELOPMENT OF DIOCOTRONIC INSTABILITY OF RELATIVISTIC ELECTRON BEAM IN COAXIAL WAVEGUIDE

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 10, Oct 83  
(manuscript received 24 Mar 83) pp 1889-1892

KALANDIYA, Z. V., KARBUSHEV, N. I., RUKHADZE, A. A. and UDOVICHENKO, S. Yu.

[Abstract] The authors analyze diocotron instability of a relativistic electron beam in coaxial cylindrical transport channels with insulated or grounded inner cylinder. The conditions for the development of instability are found for different azimuth modes, and the increments are computed. The beam is assumed to have sharp boundaries, and the electron density and longitudinal electron velocity components are cross-sectionally uniform. The system is placed in a fairly strong external longitudinal magnetic field. It is demonstrated that the conditions for the development of diocotron instability are better in a coaxial waveguide than a cylindrical one. References 3: 1 Russian, 2 Western.  
[156-6900]

# MEASURING LOCAL ION ENERGY DISTRIBUTION FUNCTION IN TUMAN-3 TOKAMAK PLASMA

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 2,  
26 Jan 84 (manuscript received 28 Nov 83) pp 76-80

GRIGOR'YEV, A. V. , ZINOV'YEV, A. N., KISLYAKOV, A. I., KOROTKOV, A. A.,  
KRZHIZHANOVSKIY, Ye. R., MAYDL', Yu. V., SHAKHOVETS, K. G. and  
SHCHEMELININ, S. G., Physicotechnical Institute imeni A. F. Ioffe,  
USSR Academy of Sciences, Leningrad

[Abstract] Two independent methods that are sensitive to different energy regions are used to study the ion energy distribution function and to determine the ion temperature on the Tuman-3 tokamak. Both methods are based on injecting a beam of fast atoms into the plasm. Analysis of the energy spectrum of atoms formed upon charge exchange of plasma ions on atoms of the injected beam gives the distribution of ions in the region of energies greater than thermal. Measurement of the shape of the  $H_{\alpha}$  line emitted by excited atoms that arise upon charge exchange on the beam with Doppler broadening gives the distribution of ions in the region of thermal energies. The atomic beam was formed by deuterium at 14 keV, injection duration was 100  $\mu$ s, and equivalent current density was 20-40 mA/cm<sup>2</sup>. The energy spectrum of atoms formed by charge exchange of plasma ions on beam atoms was recorded by a five-channel analyzer. The shape and intensity of the  $H_{\alpha}$  line were determined by a high-transmission spectrometer with Fabry-Perot interferometer as the dispersing element. Measurements were done during discharges with current through the plasma of 70 kA, a longitudinal magnetic field of 6 kGs, average density of  $10^{13}$  cm<sup>-3</sup> and electron temperature of about 200 eV. The results show that the proposed method can give information on the ion distribution function over an energy range of 0-10T<sub>i</sub>. Figures 2, references 6: 5 Russian, 1 Western.  
[124-6610]



UDC 535.31

RADIATION PROPERTIES OF OPTICAL REFLECTORS DESCRIBED BY TRIHEDRAL ANGLES  
( $\pi/2$ ,  $\pi/2$ ,  $\pi/s$ ,  $s$ -EVEN

Minsk VESTSI AKADEMII NAVUK BSSR: SERYYA FIZIKA-MATEMATYCHNYKH NAVUK  
in Russian No 1, Jan-Feb 83 pp 88-92

PROTSKO, S. V., KHANOKH, B. Yu. and KHAPALYUK, A. P.

[Abstract] The class of reflectors with deformed dihedral angles, representative of rectangular reflectors in which the angles deviate slightly from ideal to produce specific reflecting properties, is examined. The variation in the properties of these reflectors as the title quantity  $s$  varies is examined. The findings can be utilized in making the optimum choice of reflector in accordance with a particular task. Figure 1, references 8 Russian.  
[158-6900]

UDC 535.538.4+537.196

RESONANCE PHOTOIONIZATION LASER SPECTROSCOPY OF MOLECULES

Moscow USPEKHI FIZICHESKIKH NAUK in Russian Vol 142, No 2, Feb 84 pp 177-217

ANTONOV, V. S., LETOKHOV, V. S. and SHIBANOV, A. N., Institute of Spectroscopy, USSR Academy of Sciences, Troitsk (Moscow oblast)

[Abstract] Principles of visible and ultraviolet laser spectroscopy on the basis of resonance photoionization of molecules are reviewed and discussed, considering three possible modes in which molecules can become photoionized. First comes 2-step or multistep resonance photoionization in weak fields, with low saturation of optical transitions (saturation parameter  $G \ll 1$ ), corresponding to a pure  $n$ -stage process ending at the molecular ionization edge and characterized by a power-law dependence of photon yield on radiation intensity. Next comes multistep resonance photoionization in strong fields, with high saturation of optical transitions (saturation parameter  $G \approx 1$ ) and almost 100% efficiency, most important from the practical

standpoint of detection of molecules. Upon reaching the first ionization potential here, molecules continue to absorb radiation and eventually break up. The third mode is many-photon ionization, with a radiation intensity sufficient for ionization of molecules through intermediate resonances and with subsequent optical resonance transitions in the range of very high saturation ( $G \gg 1$ ). The experimental technique in any mode involves selecting the appropriate laser source, generating radiation pulses with suitable energy density characteristics otherwise matching the electronic absorption bands of molecules, synchronization of laser pulses, recording photons without segregation according to mass, and use of mass spectrometer. Measurements involve recording photoionization spectra at very low concentrations, inasmuch as photon absorption by a molecule is recorded by appearance of an ion with extremely high sensitivity. Multistep laser photoionization yields information about the kinetics of excited states and of molecule fragmentation, which is particularly useful in analysis of polyatomic molecules. An analysis of data includes construction of a statistical model, the "entropic" model being most expedient in the case of the more intricate and data-wise unwieldy many-photon ionization. Resonance photoionization can be effected by irradiation of molecules in a gas under low pressure, in which case they only negligibly collide with one another and with the container walls during action of a laser pulse. Resonance photoionization can also be effected by irradiation of a solid metal or dielectric surface. In this case, not only intrinsic molecules of the base crystal are ionized but also molecules of the adsorbate. Spectroscopy of all these molecules includes search for nonequilibrium breakaway of molecular ions, a process highly selective with regard to chromophors of large surface molecules. The main spectroscopic applications of resonance laser photoionization are detection of molecules, particularly polyatomic ones, and their subsequent mass-optical recording. The latter is a two-dimensional procedure, inasmuch as the magnitude of a mass-spectrometer output signal depends on the ion mass and on the laser radiation frequency. Figures 23, tables 1, references 114: 30 Russian, 84 Western.  
[181-2415]

UDC 666.11.01

# NEW CONCEPT OF FORMATION MECHANISM FOR PARAMAGNETIC RADIATION COLOR CENTERS IN QUARTZ GLASSES

Leningrad FIZIKA I KHIMIYA STEKLA in Russian Vol 9, No 5, Sep-Oct 83  
(manuscript received 21 Oct 81, after revision 29 Mar 83) pp 569-583

AMOSOV, A. V., Scientific Research Institute for Quartz Glass, Leningrad

[Abstract] Previous attempts to explain the radiation chemistry governing the formation of the major paramagnetic radiation color centers in quartz glass and the nature of their precursors encounter several difficulties that

this paper circumvents with a new concept. Primary attention is devoted to the chemical aspect of the radiation chemistry of network glasses and fiber optic lightguides that takes into account the actual lattice defect structure of quartz glasses, the presence of physically dissolved and structurally bound production process impurities of hydrogen, chlorine, water and oxygen in the glasses. The analysis also draws on the known data on the high radiation stimulated diffusion and chemical activity of molecules, atoms and ions in solids. Following a detailed discussion of existing models and their deficiencies, the new mechanism and color center formation schemes, both E'-centers and centers at nonbridging oxygen atoms, the paper provides an exhaustive account of the origin of stable paramagnetic and short-lived radiation color centers. The proposed model accounts for the available data on such centers and reliably predicts the efficiency of producing particular centers of this type in network glasses, depending on the production technology and the various heat treatments of the samples. The model predicts that the elimination of reduction of the concentration of H<sub>2</sub> and Cl<sub>2</sub> process impurities should significantly boost the radiation and optical stability of quartz glasses of high purity in terms of metallic microimpurities, as well as that of fiber optic lightguides in the UV and visible spectra. This conclusion is proven out with laboratory samples of high purity SiO<sub>2</sub> quartz glasses containing microimpurities of metals, OH groups and chlorine in the amount of less than 10<sup>-5</sup>% by weight. The spectra of these samples following a gamma ray dose of 2 · 10<sup>8</sup> R have practically no absorption bands at 212 and 260 nm. An important consequence of the new model is also the fact that variable valence ions are ineffective as ion protectors in quartz glasses, since the color center formation processes are not of the nature of electron and hole traps at lattice defects, but consist of changes in the microstructure of the glass lattice that are related to the formation of neutral surface radical type defects. It is clear from the model why the formation energy of the same paramagnetic radiation color centers differs in different types of quartz glasses. The thermal stability of such centers is due not to the depth of the electron or hole traps, but rather to the activation energy of the corresponding chemical reactions, which lead either to the reconstruction of defect or regular bonds, or to the transformation of some paramagnetic radiation color centers into others. The precursors of E'-centers are not oxygen vacancies or -Si<sup>+</sup> centers, but primarily -Si-H, -Si-Cl structural groups and regular -Si-O-Si- bonds with H<sub>2</sub> molecules alongside. The precursors of -Si-O<sup>-</sup> are the -Si-O-H and -Si-O--R<sup>+</sup> groups and regular -Si-O-Si- bonds with Cl<sub>2</sub>, HCl or O<sub>2</sub> molecules alongside. The precursors of the peroxy radicals are E'-centers which adsorb the physically dissolved O<sub>2</sub> molecules. Figures 3, references 75: 22 Russian, 53 Western.  
[147-8225]

## STRUCTURE OF VIBRATIONAL SPECTRUM AND SELECTION RULES IN RAMAN AND HYPER-RAMAN LIGHT SCATTERING SPECTRA OF INORGANIC GLASSES

Leningrad FIZIKA I KHIMIYA STEKLA in Russian Vol 9, No 5, Sep-Oct 83  
(manuscript received 10 Aug 82) pp 513-520

VARSHAL, B. G., DENISOV, V. N., MAVRIN, B. N., PODOBEDOV, V. G. and  
STERIN, Kh. Ye., State Scientific Research Institute for Glass, Moscow

[Abstract] While it is conventionally assumed that there are no selection rules for the wave vector and matrix element in the vibrational spectra of glasses, this paper puts forward a formulation and substantiation of a macroscopic approach to the interpretation of the spectra of glasses that consider the mean statistical symmetry of the medium. The influence of macroscopic symmetry in a glass on selection rules for vibrational spectra, using an approximation of a model developed in earlier literature for IR absorption [Whalley, et al., J. CHEM. PHYS., 1967, No 4, pp 1264-1270] and Raman scattering [Dultz, et al., J. CHEM. PHYS., 1973, No 8, pp 3365-3369] in orientationally disordered crystals, is studied for glasses exhibiting hyper-Raman light scattering. The experimental support for the proposed model is based on observations of the frequency of vibrational polaritons as a function of the scattering angle in a number of glasses, the polarization properties of the longitudinal and transverse vibration lines in the hyper-Raman scattering spectra of  $\text{SiO}_2$  and  $6\text{TiO}_2 \cdot 94\text{SiO}_2$  glasses, back-scattering in  $\text{SiO}_2$  glass as well as a direction comparison of the Raman and hyper-Raman scattering spectra of  $\text{SiO}_2$  and other glasses at various scattering angles. It is shown that the vibrational excitations (polaritons and purely mechanical oscillations) in these glasses are characterized by a definite wave vector. An alternative exclusion applies for the vibrational spectra of glasses, in accordance with which dipole oscillations are forbidden in Raman scattering; this exclusion is due to the macroscopic symmetry of the glass. The proposed new approach to the interpretation of the vibrational spectra is based on the treatment of the spectrum as composed of two parts: a crystal-like portion of the spectrum and a disordered portion. The crystal-like region has selection rules in accordance with the wave vector and the matrix element for an isotropic medium. The maximum of the spectral bands of the above glasses falls within the crystal-like region of the spectrum. Figures 4, references 16: 10 Russian, 6 Western. [147-8225]

## CHECKING OPTICAL-POLARIZATION MEASUREMENTS AT INTERFACES

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 19, No 8, Aug 83  
(manuscript received 16 Jul 82) pp 53-58

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Kiev

[Abstract] The edge effect in optically sensitive materials and mechanical loading by the measuring devices are sources of noise and error in photoelasticity measurements by optical-polarization methods made at interfaces between two media. For checking and improving the accuracy of such measurements one needs relations between the differences of normal stresses  $r = \sigma_x - \sigma_y$  and between the shearing stresses  $\tau = \tau_{xy}$ , respectively, at the boundary of and inside a medium. These relations have been established in the form of two second-order differential equations in a two-dimensional rectangular system of coordinates, one relating the two quantities  $(r, \tau)$  obtained by measurement and one relating them to each other theoretically on the basis of balance of stresses and compatibility of strains. These equations are subsequently solved, by the method of finite differences with a square grid, for the difference of principal stresses and the difference of optical paths. These two differences are related to the sought quantities  $(r, \tau)$ , through the geometry of the system, so that the latter can now be calculated precisely from readings taken at the boundary. The corresponding Cauchy problem is, for illustration, solved for an infinitely long strip with a circular hole. In one variant of calculations one corner of the square grid is placed on the edge of the hole so that the diagonal from that corner extends the diameter of the hole. In another variant of calculations the midpoint of one side of the square grid is placed on the edge of the hole so that side is symmetrically tangent to the latter. Analogous relations in algebraic form are derived for a rotating ring from the exact solution in polar coordinates and the relation between stresses in polar and rectangular coordinates respectively. Figures 5, tables 4, references 6: 5 Russian, 1 Western.  
[173-2415]

# INVESTIGATION OF SPECTRAL CHARACTERISTICS OF RADIATION OF EXIMER MOLECULES Xe<sub>2</sub>\*, XeKr\*

Moscow KRATKIYE SOOBSHCHENIYA PO FIZIKE in Russian No 10, Oct 83  
(manuscript received 25 Apr 83) pp 35-38

DEMENT'EV, V. G., DUDIN Yu. Yu., KLEMENTOV, A. D. and PENDYUR, C. A.

[Abstract] Luminescence spectra were studied using a system incorporating an electron gun, a working chamber, a vacuum monochromator and testing and diagnostic equipment. The luminescence spectrum was taken at points spaced 2 mm apart; measurements were made for xenon and different Xe:Kr mixtures. All of the luminescence spectra of the mixtures investigated have an XeKr\* eximer radiation band ( $\lambda \sim 156$  nm). When the Xe concentrations in the mixture are high (Xe:Kr=s.21) the Xe<sub>2</sub>\* band ( $\lambda = 172$  nm) is present in the radiation spectrum. The strength of this band drops off as the Xe content is reduced. Figure 1, references 5: 2 Russian, 3 Western.  
[171-6900]

UDC 535.341

## TRIPLET ABSORPTION IN POPOP MOLECULES IN GASEOUS PHASE

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 29, No 6, Dec 83  
(manuscript received 19 Aug 82) pp 969-973

BOLOT'KO, L. M.

[Abstract] A study was made for resolving the discrepancies between available data on the spectroscopic characteristics of POPOP (1,4-bis[2-(5-phenyloxazolyl)]-benzene) triplet molecules, such a molecule in the gaseous phase being a very efficient active medium for a laser with optical pumping. In the experiment these molecules were excited with second-harmonic radiation from a monopulse (15 ns half-width duration) ruby laser ( $\lambda_2 = 347$  nm) with passive Q-switching. Induced absorption at various levels of excitation intensity was recorded for a period of 300 ns after excitation so as to eliminate interference from excited singlet states. The intensity of probing radiation pulses of 800 ns half-width duration passing through nonexcited and excited POPOP specimens was recorded by the photoelectric method. The intensity of pumping radiation was regulated by means of absorbing filters. The spectra of singlet absorption and of triplet absorption with corresponding triplet optical density in POPOP vapor at  $T = 593$  K, also the dependence of triplet absorption at frequencies of 20,000 and 28,800 cm<sup>-1</sup> on the pumping radiation intensity, were determined for free POPOP molecules and for POPOP molecules in pentane under a pressure of 48 kPa. The results indicate that with increase of the pumping power

there occurs depletion of singlet and triplet states so that the POPOP vapor becomes highly transparent. Transillumination of POPOP vapor is accompanied by "heating" of molecules, which increases the probability of intercombinational conversion, by absorption of pumping radiation and by fluorescence from excited singlet and triplet molecules. Nonradiative deactivation of excited singlet states in free molecules proceeds essentially through intercombinational conversion so that a moderate pumping power density and controlled experimental conditions are necessary for measuring the spectral characteristics of triplet states. The author thanks N. A. Borisevich and V. A. Tolkachev for attentiveness and helpful discussions. Figures 2, references 13: 7 Russian, 6 Western.  
[159-2415]

UDC 535.212.621.372.8

OPTICAL BREAKDOWN AND LASER COLORING OF DIFFUSION WAVEGUIDES CONTAINING SILVER

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 12, Dec 83  
(manuscript received 15 Sep 82) pp 2403-2405

GLEBOV, L. B., NIKONOROV, N. V. and PETROVSKIY, G. T.

[Abstract] Optical breakdown and coloring of the surface of glasses in which waveguide layers are formed by diffusion of  $Ag^+$  ions are investigated. The creation of a silver diffusion waveguide on the surface of K-8 glass reduces the surface optical breakdown threshold by a factor of 7-8 since some of the silver in the waveguide is in the atomic state. Nonlinear coloring of silver diffusion waveguide is stable at room temperature, and can be employed to record information in waveguides. Figures 2, references 8: 6 Russian, 2 Western.  
[152-6900]

UDC 537.533.34

AUGER-ELECTRON ENERGY ANALYZER BASED ON CYLINDRICAL MIRROR WITH RING-AXIS FOCUSING

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 10, Oct 83  
(manuscript received 29 Nov 82) pp 2059-2065

KRACHINO, T. V. and BELOV, V. D.

[Abstract] The construction and basic parameters of an Auger spectrometer capable of recording nondifferentiated Auger spectra are examined. The use of the device to detect Auger signals is described. Nondifferentiated Auger

spectra are recorded by pulse counting at low noise levels and with a high ratio of Auger signal to secondary electron background. The possibility of using the peak of elastic reflecting electrons to calibrate the Auger spectrometer is analyzed. Figures 6, references 29: 15 Russian, 14 Western. [156-6900]

UDC 778.38:535.36

#### UNSTEADY TRANSFORMATION OF SPATIALLY HETEROGENEOUS LIGHT BEAMS BY THREE-DIMENSIONAL DYNAMIC HOLOGRAMS

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 10, Oct 83 (manuscript received 6 Aug 82) pp 1986-1994

BEREZINSKAYA, A. M., DUKHOVNYI, A. M. and STASEL'KO, D. I.

[Abstract] Unsteady amplification of radiation by three-dimensional dynamic holograms is investigated in the field of spatially heterogeneous beams for collinear and colliding propagation. The efficiency of dynamic hologram information is established quantitatively as a function of the parameters of the environment and the interacting beam. The theoretical findings are tested experimentally by recording "non-offset" dynamic holograms in a medium with a thermal nonlinearity mechanism. The experimental findings show good quantitative agreement with the theoretical results. Effective amplification of weak radiation without distortion of its spatial structure is shown to be possible in the field of intense heterogeneous beam during unsteady recording of transmitted and reflected dynamic holograms. Figures 6, references 10: 9 Russian, 1 Western. [156-6900]

UDC 535.375.55

#### OPTIMAL ENERGY AND GEOMETRIC CONDITIONS FOR RECONSTRUCTION (PHASE CONJUGATION) OF LIGHT WAVES VIA EXCITATION OF SCATTERING BY NANOSECOND AND PICOSECOND PULSES

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 47, No. 10, Oct 83 pp 2057-2060

BREKHOVSKIKH, G. L., SOKOLOVSKAYA, A. I., FER'YEV, Zh., VU, Z., RIVURAR, Kh., OKLADNIKOV, N. V. and KUDRYAVTSEVA, A. D.

[Abstract] The quality and energy intervals of reconstruction are investigated as a function of the geometry of the exciting beam and relative positioning of the active medium and actual image of the object in the pumping light in order to find optimum conditions for object image reconstruction



using stimulated scattering. The effectiveness of the reconstruction was estimated by determining the localization of the image of the object in the stimulated scattering beam and measuring its transverse dimensions. The distribution of the stimulated scattering energy in the spatial frequency spectrum is studied, and comparisons are made with the Fourier spectrum of the exciting radiation. Figures 3, references 7: 5 Russian, 2 Western. [162-6900]

UDC 535.21

BIOLOGICAL EFFECT OF LOW INTENSITY VISIBLE LIGHT ON CELLS AS FUNCTION OF RADIATION PARAMETERS - COHERENCE, DOSE AND WAVELENGTH

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 47, No 10, Oct 83 pp 2017-2022

KARU, T. I., KALENDO, G. S. and LOBKO, V. V.

[Abstract] The effect of biostimulation of cells in a fiber cluture is investigated in order to define the optimal conditions for the stimulating effect of light and to study the molecular mechanism underlying the effect of photoregulation of metabolic processes within cells. The effect of low intensity visible and near IR radiation on the rate of DNA synthesis in the cell culture is studied. The DNA synthesis rate is shown to increase with maxima near 400, 620 and 750 nm. Figures 4, references 12: 6 Russian, 6 Western. [162-6900]

UDC 621.373.826:535.375.56

COHERENT SPECTROSCOPY OF HIGHER OSCILLATING STATES OF POLYATOMIC MOLECULES. SPECTRAL CHARACTERISTICS OF QUASI-CONTINUUM

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 47, No 10, Oct 83 pp 1931-1939

AMBARTSUMYAN, R. S., AKHMANOV, S. A., GLADKOV, S. M., ZADKOV, V. N., YEVSEYEV, A. V., KARIMOV, M. G., KOROTEYEV, N. I. and PURETSKIY, A. A.

[Abstract] This study presents the findings of experimental and theoretical investigations of the nonlinear optical susceptibility of vibrationally excited polyatomic molecules. The experiments employed coherent active spectroscopy of Raman scattering. Studied experimenatly and analytically were the movement of populations during near collision-free excitation of SF<sub>6</sub> molecules under the action of resonant IR laser excitation and subsequent

vibrational relaxation; the position of the boundary of the vibrational quasicontinuum in an  $\text{SF}_6$  molecule is estimated, as is the amount of uniform transition expansion. Figures 5, references 12: 6 Russian, 6 Western.  
[162-6900]

UDC 621.391.029.7

#### NONLINEAR PHENOMENA IN OPTICAL FIBERS

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 47, No 10, Oct 83 pp 1951-1954

SOKHOR, V., TAM, T.T. and VARGA, F.

[Abstract] Stimulated Raman scattering in light guides is examined with the use of three nonlinear differential equations for the amplitudes of the pumping lattice oscillations and signal. The generation of Stokes components lags for propagation along the fiber, and reaches its maximum value at specified distances. The Stokes component pumping power is higher for fibers with high attenuation, and the pumping wave also attenuates as a function of the coupling coefficient. The generation of anti-Stokes components is possible, but the probability that they will be detected is several orders of magnitude lower than that for Stokes components. The propagation of soliton pulses in fiber optic light guides is modeled. Figures 4, references 6 Western.  
[162-6900]

UDC 621.391.029.7

#### NONLINEAR PHENOMENON AND FIBER-OPTICS LIGHT GUIDES

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 47, No 10, Oct 83 pp 1874-1879

PROKHOROV, A. M.

[Abstract] This article reviews work being done in the USSR and elsewhere on nonlinear phenomena in fiber-optics light guides, including stimulated Raman scattering in fused quartz, stimulated Brillouin scattering, four-photon mixing and intrinsic interaction of light pulses. The problem of reducing the influence of dispersion on the amount of information that can be transmitted is discussed. The development of low-loss light guides will make it possible to develop communications links that can operate over hundreds of kilometers without requiring the use of repeater stations. References 22: 11 Russian, 11 Western.  
[162-6900]

## KINETICS OF ACCUMULATION OF INTRINSIC DEFECTS IN IRRADIATED QUARTZ

Tashkent IZVESTIYA AKADEMII NAUK UzSSR: SERIYA FIZIKO-MATEMATICHESKIKH  
NAUK in Russian No 6, Nov-Dec 83 (manuscript received 29 Aug 81) pp 45-48

ABDUKADYROVA, I. Kh., Institute of Nuclear Physics, UzSSR Academy of Sciences

[Abstract] A comprehensive spectroscopic study is done on structural changes in quartz after reactor irradiation. Optical luminescence spectra were analyzed before and after irradiation of quartz crystal and vitreous silica. Optical excitation was by ultraviolet light on wavelengths of 290 and 470 nm. The results show that luminescence is intrinsic, and spectroscopic characteristics are the same in both irradiated modifications. Curves are given for the dose dependence of luminescence intensity for the two modifications. In the case of the quartz crystal, certain anomalies in the kinetics of defect accumulation are noted in the dose range of  $10^{18}$ - $10^{21}$  f.n./cm<sup>2</sup>. It is suggested that the anomalies may be due to transformations of the crystal structure. Figure 1, references 7: 6 Russian, 1 Western.  
[112-6610]

## STUDIES OF RADIATION-OPTICAL PROPERTIES OF PHOSPHATE GLASSES HEAT-TREATED UNDER TERRESTRIAL AND SPACE CONDITIONS

Tashkent IZVESTIYA AKADEMII NAUK UzSSR: SERIYA FIZIKO-MATEMATICHESKIKH  
NAUK in Russian No 6, Nov-Dec 83 (manuscript received 20 Oct 81) pp 48-51

IKRAMOV, G. I., ISAYEV, I. Kh., KAL'VAN, V. A., SALAKHITDINOV, A. N.,  
SEMESHKIN, I. V. and PETROVSKIY, G. T., Samarkand State Pedagogical Institute  
imeni S. Ayni, State Optics Institute imeni S. I. Vavilov

[Abstract] An experimental study is done of the effect that microgravitation ( $g \leq 10^{-3}$ ) has on transparency, G.T.) structural homogeneity and luminescence of glass. The radiation-optical characteristics were determined for three types of phosphate glass doped with cerium and antimony: 1--initial glass specimens; 2--specimens heat-treated in a facility simulating temperature and time conditions of melting in outer space; 3--specimens heat-treated under conditions of microgravitation on the Splav facility. Differences are observed in the absorption spectra and also in the photo-, gamma- and thermoluminescence spectra: the absorption edge of glass heat-treated under low gravity is shifted toward longer wavelengths, and there is a considerable reduction in the difference of intensities of absorption curves from the gamma-exposure dose. Figures 3, references 6 Russian.  
[112-6610]

# INVESTIGATION OF PHOTSENSITIVE FILM STRUCTURES WITH UPPER OPTICAL WINDOW HAVING WIDE FORBIDDEN BAND

Tashkent IZVESTIYA AKADEMII NAUK UzSSR: SERIYA FIZIKO-MATEMATICHESKIKH NAUK in Russian No 6, Nov-Dec 83 (manuscript received 6 Apr 83) pp 54-56

AKHMEDOV, R. and RASULOV, D. T., Dzhizak State Pedagogical Institute

[Abstract] The paper gives the results of a study of electrophysical and photoelectric properties of film pn junctions based on cadmium telluride with upper wide-band optical window of  $\text{Zn}_x\text{Cd}_{1-x}\text{S}$  made by thermal sputtering in a vacuum of  $\sim 10^{-5}$  mm Hg using ZnS and CdS powders from individual controlled sources onto a backing of p-CdTe produced by resublimation in a quasi-closed space in a stream of hydrogen. It is found that photosensitivity of the p-CdTe-n-CdTe-n- $\text{Zn}_x\text{Cd}_{1-x}\text{S}$  structure appears beyond the fundamental absorption band of  $\text{Zn}_x\text{Cd}_{1-x}\text{S}$  and has a maximum at the photon energy corresponding to the width of the cadmium telluride forbidden band. The shortwave edge of photosensitivity depends on the zinc content in  $\text{Zn}_x\text{Cd}_{1-x}\text{S}$ , shifting toward shorter wavelengths with increasing zinc content. Figures 2, references 3: 2 Russian, 1 Western.  
[112-6610]

UDC 537.534

# INFLUENCE OF COLLECTIVE EFFECTS ON LOCAL-FIELD RESONANCE WHEN RADIATION INTERACTS WITH ROUGH SOLID SURFACE

Moscow POVERKHNOST': FIZIKA, KHIMIYA, MEKHANIKA in Russian No 2, Feb 84 (manuscript received 17 Jan 83) pp 38-43

YEMEL'YANOV, V. I., ZEMSKOV, Ye. M. and SEMINOGOV, V. I.

[Abstract] A theory of the local field on a rough surface is constructed based on the microscopic model, with consideration of collective effects. Asperities are modeled by cylinders with finite and arbitrary longitudinal and transverse dimensions randomly distributed over a plane surface. An analysis is made of the influence that dipole-dipole interactions between asperities have on displacement of the resonant frequency of the local field. Explicit relations are derived for the factor of the effective field  $\beta$  and frequency  $\omega_r$  as dependent on the geometry and surface density of asperities, as well as the polarization of the light wave acting on the surface. It is shown that under certain conditions on metals, frequency  $\omega_r$  may be shifted from the ultraviolet into the optical and infrared regions of the spectrum due to collective effects alone. Figures 2, references 10: 3 Russian, 7 Western.  
[113-6610]

## SPLITTING OF SURFACE POLARITON SPECTRUM BY HOLOGRAPHIC GRATING

Moscow POVERKHNOST': FIZIKA, KHIMIYA, MEKHANIKA in Russian No 2, Feb 84  
(manuscript received 27 Oct 81) pp 44-47

GORYACHEV, D. N., DMITRUK, N. L., KAMUZ, A. M. and LITOVCHENKO, V. G.,  
Institute of Physics of Semiconductors, UkSSR Academy of Sciences, Kiev,  
Physicotechnical Institute imeni A. F. Ioffe, USSR Academy of Sciences,  
Leningrad

[Abstract] The authors study the spectra of surface phonon polaritons in the presence of a holographic diffraction grating on the surface of GaAs single crystals. Gratings of two types were studied: with space frequency of  $10^2 \text{ mm}^{-1}$  and grating depth of 1.0-1.1  $\mu\text{m}$ , and with space frequency of  $19 \text{ mm}^{-1}$  and grating depth of 1.5  $\mu\text{m}$ . The profile of the lines was sinusoidal. The attenuated total reflection technique was used for exciting surface phonon polaritons. The ATR spectra were taken at room temperature with two orientations of the diffraction grating relative to the plane of incidence of radiation on the coupling prism. In the first case the wave vector of the grating was parallel to the plane of incidence, and in the second--perpendicular to it. Splitting of the spectrum of surface phonon polaritons is observed, and an analysis is made of the relation between the splitting parameters and grating characteristics. Figures 2, references 7: 2 Russian, 5 Western.  
[113-6610]

## MEASUREMENT OF ABSORPTION SPECTRA OF HIGH-TRANSPARENCY INFRARED MATERIALS BY LASER CALORIMETRY METHOD

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 12, Dec 83  
(manuscript received 7 Dec 82) pp 1-4

PLOTNICHENKO, V. G. and SYSOYEV, V. K.

[Abstract] The article describes a calorimetric facility designed for spectral measurements of coefficients of volumetric and surface absorption of high-transparency solids in the mid-IR range. The facility consists of three major components: a set of radiation sources, a system for recording emission spectra, and a unit for calorimetric measurements of absorption coefficients. The set of emission sources includes Co,  $\text{Co}_2$ , He-Ne and  $\text{YAG:Nd}^{3+}$  lasers. A table is given summarizing the attainable levels of volumetric absorption for CO and  $\text{CO}_2$  lasers in measurements on KRS-5, KRS-6, KCl, CsI,  $\text{As}_2\text{S}_3$  and  $\text{As}_2\text{Se}_3$ . An examination is made of ways to increase sensitivity and extend the range of the facility. Volumetric and surface absorption spectra are given for KRS-5 and CsI. Figures 4, table 1, references 13: 6 Russian, 7 Western.  
[106-6610]

INVESTIGATION OF RADIATION LOSSES ON OPTICAL COMPONENTS AS DEPENDENT  
ON PHYSICAL PARAMETERS OF SURFACE LAYER

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 12, Dec 83  
(manuscript received 29 Dec 82) pp 5-7

PSHENITSYN, V. I. and KHRAMTSOVSKIY, I. A.

[Abstract] A study is done on radiation losses on the polished surface of optical components as a function of the physical parameters of the surface layer determined by an ellipsometric method. The effective values of the index of refraction and the depth of the surface layer were determined by measuring the polarization angles upon conversion of a linearly polarized incident light beam to elliptical polarization with reflection from the surface, and solution of the inverse problem of ellipsometry. Analysis of curves showing the changes in the index of refraction, depth of the surface layer, and radiation losses with increasing polishing time can give information on the part played by the abrasive in forming optical properties of the surface layer and in losses of radiation on a polished surface, based on the hypothesis that products of abrasive destruction are incorporated into the surface layer. A spread is observed in radiation losses for identically clean surfaces with the same accuracy of shape, showing that physical parameters have a considerable effect on radiation losses. Figures 2, tables 2, references 6 Russian.  
[106-6610]

UDC 621.378.3-535.853.4

USING TWO-BEAM INTERFERENCE METHOD FOR MEASURING WAVELENGTH OF TUNABLE  
PULSE LASERS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 12, Dec 83  
(manuscript received 24 May 83) pp 46-47

ARKHIPOV, V. V., KURBATOV, A. L. and SHUBIN, M. V.

[Abstract] Two-beam interference is used to measure pulsed laser wavelength. The experimental facility is based on a scanning Michelson interferometer that contains a beam splitter made from a BaF<sub>2</sub> crystal with titanium layer, stationary and movable flat mirrors and a reference laser. In the experiment, the emission from a semiconductor injection laser was coupled through a collimator objective lens into the interferometer. At the output of the interferometer was a Ge(Hg) photocell. A wide-band pre-amplifier matched the photocell to the external amplifier. The amplified signal was displayed on a CRT scope. The results of the experiment

demonstrate the feasibility of measuring wavelength of frequency-tunable lasers by the two-beam interference method with a scanning Michelson interferometer and dynamic band counting. Figures 2, references 5 Russian. [106-6610]

UDC 681.7.068.4.013

#### PROPAGATION OF PICOSECOND PULSES THROUGH LIGHT GUIDES

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 12, Dec 83 (manuscript received 19 Mar 82) pp 49-50

GOLUBENKO, I. V., IVANOV, V. B., NESTEROVA, Z. V., PIVINSKIY, Ye. G., PRILEZHAYEV, D. S. and SATTAROV, D. K.

[Abstract] The authors investigate the frequency properties of quartz and silicate fiber-optics light guides when light pulses of 5 ps duration are transmitted through them. The pulses at the input and output of the light guide are photographed by the Agat-SF camera with resolution of about 3 ps. It is found that the shape of the pulse at the output from the light guide is near gaussian with half-intensity duration of about 400 ps. Figure 1, references 4 Russian. [106-6610]

UDC 538.574.4

#### INFRARED ABSORPTION IN COPPER FILMS AT LOW TEMPERATURES

Moscow POVERKHNOST': FIZIKA, KHIMIYA, MEKHANIKA in Russian No 11, Nov 83 (manuscript received 1 Oct 82) pp 16-21

DUBININA, G. A., LIBENSON, M. N. and FEDEROV, N. F., deceased, Leningrad Polytechnical Institute imeni M. I. Kalinin

[Abstract] The authors study the optical and electrical properties of copper films deposited on glass backings in vacuum (control specimens) and in a stream of helium with vapor pressure of about 0.01 mm Hg introduced into an evacuated space. The films were deposited at temperatures of 220, 420 and 740°C and condensation rates of  $2.5 \pm 0.5$ ,  $3.7 \pm 9.7$  and  $6.8 \pm 1.2$  nm/s. Film thickness was 1.5-3  $\mu$ m. Measurements were made of the electrical conductivity of the specimens by a four-probe method at room temperature and at the boiling point of helium (4.2 K). Other things being equal, conductivity was always higher when the films were applied in a helium flow. Conductivity also increases with a reduction in sputtering rate, but no definite dependence on substrate temperature was observed. Film surfaces grown to a thickness of several micrometers in a stream of helium lost optical quality in the visible part of the

spectrum. These surfaces were studied under the electron microscope at a magnification of 20,000 and were found to consist of small crystals of a size increasing with transition from vacuum to helium sputtering, and also with increasing substrate temperature and sputtering rate, ranging from 0.1 to 203  $\mu\text{m}$ . The results of these studies can be used to evaluate the limiting absorptivity of copper films, i.e., the absorption associated with processes of electron scattering in a perfect specimen. The value is found to be  $\sim 10^{-4}$  for initial temperature of 4.2 K and final temperature of 77.7 K at wavelengths of 30-50  $\mu\text{m}$ . Tables 5, references 10: 9 Russian, 1 Western.  
[130-6610]

UDC 535.3

#### SELF-OSCILLATIONS WITH LASER VAPORIZATION OF DIELECTRICS

Moscow POVERKHNOST': FIZIKA, KHIMIYA, MEKHANIKA in Russian No 11, Nov 83  
(manuscript received 23 Aug 82) pp 22-27  
Gol'berg, S. M., Tiibel'skiy, M. I. and Kholkhoy, V. A.

[Abstract] The paper gives a numerical analysis of the plane unsteady problem of laser vaporization of nonlinearly absorbing dielectrics. It is shown that a steady-state vaporization wave is stable only in a certain range of values of laser intensity and thermophysical characteristics of matter. It is predicted that there should be stable self-oscillatory modes of vaporization. The question of critical priming (regions of lock-in on initial conditions) is investigated for both steady-state and self-oscillatory vaporation waves. It is shown that in a certain range of parameters of the problem, a stable vaporization wave will not exist: any initial perturbations of the temperature field die out in time, and the dielectric relaxes to the "cold" state with zero temperature and complete absence of absorption. Figures 4, references 12: 11 Russian, 1 Western.  
[130-6610]



INFLUENCE THAT DEPOLARIZATION OF STIMULATING RADIATION IN AXISYMMETRIC OPTICAL COMPONENTS HAS ON CHARACTERISTICS OF STIMULATED BRILLOUIN SCATTERING

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 2, 26 Jan 84 (manuscript received 17 Nov 83) pp 87-90

VASIL'YEV, M. V., VENEDIKTOV, V. Yu., MIT'KIN, V. M., SEMENOV, P. M. and SIDOROVICH, V. G.

[Abstract] An experimental study is done on excitation of stimulated Brillouin scattering by a light beam transmitted through axisymmetrically anisotropic glass rods, and conditions are found under which phase-conjugated reflection in a Brillouin mirror provides satisfactory compensation for the distortions due to such rods. The light source was a GLS-22 glass laser, and the anisotropic rods were made of GLS-1 glass. The measure of anisotropy was the number  $n$  of rings in the conoscopic pattern produced on a wavelength of  $0.63 \mu\text{m}$ . It was found that the reflectance of an acetone-filled Brillouin cell decreases with increasing  $n$  because of distortion of the waveshape by the polarization component that contains most of the energy. Wavefront distortion also causes a reduction in the fraction of energy of the Stokes wave emitted into a small reference angle. The results of the experiments show that axisymmetric anisotropy causes a slight reduction in the emission brightness when a Brillouin mirror is used to compensate for inhomogeneities of optical components in which polarization of the phase-conjugated Stokes wave is parallel to the polarization of the exciting radiation. Figures 2, references 5 Russian. [124-6610]

INVESTIGATION OF IONIZATION PROCESSES DURING OPTICAL EXCITATION OF METAL ATOM BEAM

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 2, 26 Jan 84 (manuscript received 22 Jul 83) pp 114-117

ZAGREBIN, S. B. and SAMSON, A. V.

[Abstract] A technique based on using an atomic beam in combination with optical excitation is used to study processes of ionization of atoms of sodium, potassium, rubidium and barium. The atomic beam was produced by vaporizing the metals in a crucible. The concentration of alkali metal atoms in the zone of optical excitation ranged from  $5 \cdot 10^{11}$  to  $10^{12} \text{ cm}^{-3}$ . To select the stimulating radiation, a monochromator was used to isolate a given wavelength band from the continuous spectrum of a xenon lamp. A calibrated photocell was used to measure the energy characteristics of the stimulating radiation, and the signal was detected by an electrometric amplifier. A secondary electron multiplier and counter were used for ion registration. A time-of flight method was used for mass analysis

of the ions, enabling correct identification of the measured ion signal with specific ionization processes. The results enable determination of the rate constants and effective cross sections of the different channels of collisional ionization, and show their dependence on the principal quantum number  $n$ , as well as determining the effective photoionization cross sections of alkali molecules. Rate constants and effective cross sections of the investigated processes are to be published in another paper in the near future. Figures 2, references 5: 4 Russian, 1 Western. [124-6610]

#### SPATIAL INVERSION OF POPULATION DIFFERENCE OF hfs SUBLEVELS OF CESIUM ATOM GROUND STATE IN OPTICAL PUMPING

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 1, 12 Jan 84 (manuscript received 11 Nov 83) pp 36-39

GORNYI, M. B., DOVATOR, N. A., ZHITNIKOV, R. A. and MATISOV, B. G.

[Abstract] The effect of spatial inversion of the difference in populations of the sublevels of the hyperfine structure of the ground state of cesium atoms during optical pumping is established and subjected to theoretical analysis and experimental study. The essence of the effect is that in optically thick cells the difference of populations of hfs sublevels with  $F, m_F: (4.0)$  and  $(3.0)$  changes sign along the cell. In the experiments, the optical thickness of the cell was varied by changing its temperature, thus changing the density of the alkali metal vapor. Curves for the magnetic resonance signal as a function of the distance between the center of the diaphragm and the front window of the cell for different temperatures show that inversion of the magnetic resonance signal takes place, the "zero point" moving toward the front window of the cell as temperature increases. Theoretical analysis of the observed effect was based on simultaneous solution of the equation for the density matrix of cesium atoms and the transport equation that determines the change in intensity of the light of optical pumping along the cell. Radiation transport was considered at the frequencies of spectral lines, enabling correct accounting for the shape of the actual emission and absorption lines. To do this, the solution was based on a propagation function having the sense of nonlinear optical length. The observed effect can be attributed to the fact that the rate of optical pumping from the upper hyperfine sublevel decreases lengthwise of the cell more rapidly than the rate of pumping from the lower hyperfine sublevel since the upper sublevel has greater absorptivity because of greater statistical weight. Figures 2, references 6: 3 Russian, 3 Western. [121-6610]

# USING FIBER-OPTICS LIGHT GUIDES IN DIAGNOSING INTENSE SHOCK WAVES

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 1,  
12 Jan 84 (manuscript received 10 Nov 83) pp 55-60

BESPALOV, V. Ye., BUBNOV, M. M., VOVCHENKO, V. I., DEMIDOV, B. A.,  
DIANOV, Ye. M., IVKIN, M. V., KRASYUK, I. K., PASHININ, P. P.,  
PROKHOROV, A. M., NEFEDOV, S. M., RUDAKOV, L. I., SKLYAROV, S. N. and  
FORTOV, V. Ye., Institute of General Physics, USSR Academy of Sciences,  
Moscow

[Abstract] The article is a report on research for the purpose of demonstrating that the use of fiber-optics light guides for coupling a study object to recording equipment avoids many experimental difficulties associated with optical methods of diagnosing intense shock waves. Multimode stepped-index light guides were used. The core diameter was 50  $\mu\text{m}$ , and the outside diameter was 125  $\mu\text{m}$ . The numerical aperture of the fiber was 0.24. The fibers were encased in a polymer shell 400  $\mu\text{m}$  in diameter. The time of propagation of a shock wave was determined from emergence of the wave onto the flat or stepped surface of a target facing the light guide. Shock waves were produced by metal explosion, relativistic electron beams and laser emission. The results show that fiber-optics light guides can be successfully used in experiments explicitly set up for studying intense shock wave physics. Precision techniques such as interference and polarization methods can be designed around the use of these light guides. Figures 2, references. 9 Russian.  
[121-6610]

UDC 582.22-582.31/9:532

## ARRIVAL OF RADIATION AT COMBINED PHOTORECEIVER SURFACE UNDER NATURAL IRRADIATION

Ashkhabad IZVESTIYA AKADEMII NAUK TURMENSKOY SSR: SERIYA FIZIKO-  
TEKHNIЧЕСКИХ, KHIMICHESKIKH I GEOLOGICHESKIKH NAUK in Russian No 5,  
Sep-Oct 83 (manuscript received 23 Aug 82) pp 45-48

BAYRAMOV, R. B., AMANOV, Ch. A., KURBANNIYZAOV, Ch. S., MYNDAYEV, N. M.  
and KRAVCHENKO, V. L., Solntsa Scientific Production Association,  
TuSSR Academy of Sciences

[Abstract] The authors give the results of tests of a six-section combined cylindrical photosynthetic chlorella cultivator developed at Solntsa Scientific Production Association. The unit is capable of operation under both natural and artificial irradiation. Tests were done in all seasons with the facility operating under artificial illumination from October through March, and on solar radiation from April through September. The results of tests showed stable operation both with respect to efficiency of converting solar radiation (photosynthetic part of the spectrum), and with respect

to mean daily productivity. The design of the photoreactor is a decisive factor. The hexagonal configuration of the combined facility presents a cross section to solar radiation that varies little with movement of the sun. The results of these tests confirm the validity of a progressive systems approach with combined application of heat and illumination engineering along with the handling of biological problems. Figure 1, tables 2, references 3 Russian.  
[116-6610]

UDC 621.315.592:537.311.33

INFLUENCE THAT COMPOSITION OF GAS PHASE HAS ON PHOTOLUMINESCENCE SPECTRA OF EPITAXIAL LAYERS OF  $\text{Ga}_x\text{In}_{1-x}\text{As}_y\text{P}_{1-y}$  ( $0.07 < x < 0.09$ ;  $0.15 < y < 0.18$ )

Minsk VESTSI AKADEMII NAVUK BSSR: SERYYA FIZIKA-MATEMATYCHNYKH NAVUK in Russian No 6, Nov-Dec 83 (manuscript received 24 Dec 82) pp 84-87

GRUZDEV, Yu. A., MANEGO, S. A. and TIKHONENKO, O. Ya.,  
Institute of Electronics, BSSR Academy of Sciences

[Abstract] Epitaxial layers of  $\text{Ga}_x\text{In}_{1-x}\text{As}_y\text{P}_{1-y}$  with  $x$  ranging from 0.07 to 0.09 and  $y$  ranging from 0.15 to 0.18 were grown on InP backings by gas-phase epitaxy in the hydride-chloride system in a facility with vertical reactor. Photoluminescence spectra were taken by a standard technique with synchronous detection. He-Cd laser excitation and a germanium photocell. The composition of the films was determined by an x-ray microanalyzer with accuracy of  $\pm 5\%$ . The structure of the spectra was determined as a function of the ratio of gas phase components:

$$n = \frac{\text{PH}_3}{\text{PH}_3 + \text{AsH}_3} \frac{\text{Ga(HCl)}}{\text{Ga(HCl)} + \text{In(HCl)}}$$

and it is shown that deviation of  $n$  by 15% from the optimum increases the half-width of the fundamental band A and reduces its intensity. Deviation of  $n$  from the optimum toward smaller values gives rise to a long-wave band at  $h\nu = 0.93-1.05$  eV in the photoluminescence spectra at 77 K. This band is attributed to radiative transitions to deep levels associated with a complex incorporating an interstitial gallium atom, a vacancy of a group III element and an oxygen atom. Figures 2, references 4: 2 Russian, 2 Western.  
[133-6610]

SELECTING PARAMETERS OF OPTICAL SYSTEMS OF SPECTROMETRIC LIDAR

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 12, Dec 83  
(manuscript received 6 April 83) pp 16-18

DANICHKIN, S. A.

[Abstract] An examination is made of the problem of optimizing the optical parameters of a spectrometric lidar of coaxial design with single-slit spectral device installed in such a way that the plane of the input slit is separated from the focal plane of the objective lens by a distance determined by the range focusing of the objective lens. Relations are derived for evaluating the characteristics of the optical systems of different spectrometric lidars, and a table is given summarizing the results of analysis of twelve geometric parameters of four lidars. These data show that the given lidars have optical characteristics that are far from optimum, with room for improvement by a factor of 1.5-2. The proposed simple technique for estimating characteristics of optical components can be used for optimizing lidar systems on early design stages. Figures 2, table 1, references 7: 6 Russian, 1 Western.  
[106-6610]

OPTIMIZING PARAMETERS OF GAS-DISCHARGE LIGHT PULSE GENERATORS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 12, Dec 83  
(manuscript received 3 May 83) pp 14-16

DEMCHUK, M. I., DMITRIYEV, S. M. and AFANAS'YEV, N. N.

[Abstract] A technique is presented for metrological certification of widely used gas-discharge light generators. A method is described for optimizing their parameters (pulse duration, stability of pulse shape, energy and so on). Results are given from investigation of a high-intensity nanosecond light pulse generator developed by the authors. In this device,

the surface of a thick electrode 8 mm in diameter forms a homogeneous co-axial line with the inside surface of a hollow cylinder, minimizing pulse duration, and reducing the frequency of microwave pickup. This light pulse generator is used as the base component of a pulse photometer. Figures 4, table 1, references 15: 8 Russian, 7 Western.  
[106-6610]

UDC 538.566.5

INVESTIGATION OF SPECTRAL AND ABERRATION CHARACTERISTICS OF OPTICAL CHANNEL MULTIPLEXER AND DEMULTIPLEXER BASED ON PLANAR WAVEGUIDES

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 12, Dec 83  
(manuscript received 15 Oct 82 revised 6 Jun 83) pp 2387-2393

SYCHUGOV, V. A., SVAKHIN, A. S. and TULAYKOVA, T. V.

[Abstract] This study examines the possibility of increasing the number of data channels that can be multiplexed to 30-40, providing reliable operation with a wide source spectral radiation band, and employing the system in the multiplexing mode as a multiplexer. The possibility of reducing longitudinal aberrations is investigated experimentally, and a formula is given for calculating the spectral band of the device. A channel multiplexer is fabricated and investigated. Figures 4, references 8: 5 Russian, 3 Western.  
[152-6900]

UDC 535.215.4

CONVERSION OF LIGHT FIELD TO ELECTRICAL SIGNAL DURING NONLINEAR OPTICAL-ACOUSTIC INTERACTION IN PHOTOCONDUCTING PIEZOELECTRICS

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 12, Dec 83  
(manuscript received 28 Feb 83) pp 2373-2377

DEYEV, V. N. and PYATAKOV, P. A.

[Abstract] The title interaction is analyzed theoretically and the possibilities of its use are discussed. A solution is obtained which describes the effect of generation of variable acoustic emf during nonlinear mixing of two coherent light waves formed through the interference of a photoinduced grid of charge carriers and two acoustic waves are coupled with one another and with the charge carrier grid by the current concentration nonlinearity mechanism. The possibility of employing this effect to convert the spatial distribution of complex amplitude of a light field (spatial optical signal)

to an electrical signal and to execute such function operations as convolution and Fourier transformation is demonstrated. Some advantages of the nonlinear interaction over linear are examined. Figures 2, references 6: 3 Russian, 3 Western.  
[152-6900]

UDC 625.396.925

MODELING HOLOGRAPHIC RECOGNITION SYSTEM BY USING NUMBER-THEORY CONVOLUTION TRANSFORMATION

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 12, Dec 83 (manuscript received 13 Sep 82) pp 50-51

FEDOROV, B. F. and KHALIMOV, G. Z.

[Abstract] The authors consider the problem of computer simulation of holographic recognition systems. An analysis is made of a number-theory transform method for image processing where the brightness relief is represented by a matrix of binary numbers. The number-theory convolution transformation method saves computer time and storage capacity in this case over fast Fourier transformation techniques since it is the amplitude response that is required at the filter output, and therefore the operations of complex multiplication and addition required by FFT are redundant. The number-theory transform also gives a more exact representation of quantized data as it is not limited by the round-off and overflow problems of FFT. Software limitations are considered. References 5 Russian.  
[106-6610]

UDC 933.951

STRONGLY NONLINEAR WAVES IN RELATIVISTIC PLASMA

Dushanbe DOKLADY AKADEMII NAUK TADZHIKSKOY SSR in Russian Vol 26, No 9,  
Sep 83 (manuscript received 14 Feb 83) pp 571-573

KHAKIMOVA, M. and KHAKIMOV, F. Kh., Tajik State University imeni V. I Lenin

[Abstract] Formation of soliton arrays in a relativistic plasma as a result of modulation instability is analyzed for the case of low-energy particles in the system and an accordingly only slightly varying particle distribution function. The corresponding expression for the energy field is derived from the solution to the wave equation for amplitude and phase of a soliton.

Article was presented by Academician A. A. Adkamov (TaSSR Academy of Sciences) on 18 April 1983. References 2 Western.

[163-2415]

UDC 533.95

SOLITONS IN PLASMA MOVING AT NEAR-SONIC VELOCITY

Moscow KRATKIYE SOOBSHCHENIYA PO FIZIKE in Russian No 10, Oct 83  
(manuscript received 16 May 83) pp 52-57

ANDREYEV, N. Ye., SILIN, V. P. and SILIN, P. V.

[Abstract] Solutions are obtained for s-polarized waves in a steady-state plasma flow moving at near sonic velocity. These solutions demonstrate the simple analytical principles that correspond to the transition of the plasma from subsonic to supersonic and back, including the principles that determine the structure of original solitons. Figure 1, references 4 Russian.

[171-6900]



## FORMATION OF PLASMA NEAR WALLS IN ELONGATED VACUUM CHANNELS

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 10, Oct 83  
(manuscript received 27 Jan 82) pp 1928-1931

KORENEV, S. A. and RUBIN, N. B.

[Abstract] The authors propose and demonstrate experimentally that a uniform plasma can be formed near the walls in elongated channels with residual gas pressure of  $p \sim 10^{-5}$  Tor on the basis of incomplete discharge along the surface of the dielectric. Basic formulas for developing the proposed plasma channels are presented. Figures 6, references 7 Russian.  
[156-6900]

## STRONG-CURRENT STAGE OF LIGHT-INITIATED SURFACE DISCHARGE

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 53, No 10, Oct 83  
(manuscript received 4 Jan 83) pp 1916-1921

BEDRIN, A. G., PODMOSHENSKIY, I. V. and ROZOVTSSEV, P. N.

[Abstract] The final, strong-current stage of light-induced surface discharge is studied experimentally in order to record electrical and optical characteristics. The strong-current stage occurs as a pulse arc discharge which differs from an ordinary surface discharge in that the excess pressure is smaller, the current channel is flat and the erosion composition of the plasma is not the same. Figures 4, references 8 Russian.  
[156-6900]

## STRESS, STRAIN AND DEFORMATION

### PARAMETERS OF CHARGE AND EFFECTIVENESS OF UNDERGROUND DETONATION

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 19, No 6, Nov-Dec 83  
(manuscript received 15 Oct 82) pp 58-65

KUZNETSOV, V. M. and SHATSUKEVICH, A. F., Moscow

[Abstract] The effectiveness of underground detonation is defined as the ratio of the displaced or ejected earth volume to the explosion energy, while the efficiency of detonation is defined as the ratio of the residual (after cooling) "useful" thermal energy to the initially available energy. All these quantities are evaluated from their dependence on the parameters of the explosive charge and on the conditions of detonation, in accordance with the first law of thermodynamics as well as relevant heat and mass transfer relations. As an experimentally validated practical assumption, the gas bubble and with it the cavity it occupies are assumed to expand adiabatically while wall cooling or sorption at the wall occur instantaneously. The "dynamite equivalent" is introduced for reference and calibration. Also given are numerical data on 27 common explosives used and semi-empirical formulas that yield the performance characteristics of charges ("bombs") containing them. Figure 1, tables 2, references 27: 23 Russian, 4 Western.  
[154-2415]

UDC 534.16:539.374

### PLASTIC DEFORMATION AND MICROSTRUCTURAL TRANSFORMATIONS OF METALS UNDER SHOCK WAVES

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 19, No 5, Sep-Oct 84  
pp 123-126

MAKAROV, P. V., PLATOVA, T. M. and SKRIPNYAK, V. A., Tomsk

[Abstract] A model of plastic deformation is constructed for metals under shock waves, with individual treatment of mechanisms of flaw structure transformations under the elastic precursor, under the plastic load wave, and under the load relaxation successor respectively. This model is based

on the relation between the shearing strain rate and average microstructural parameters, the latter including both density and orientation of defects, the mean collective propagation velocity of defects, the Burgers vector, also the Bauschinger effect and the loading history. The equations of this model have been solved by numerical simulation for shock waves of up to 10 GPa intensity impinging on three aluminum alloys (Al-1060, Al-6061, D-16). The results, which depict the evolution of stress waves and the inception of dislocation as well as the kinetics of the free surface depending on the barrier thickness, reveal that heterogeneous inception of dislocations plays a significant role in development of plastic flow in a shock wave and determines the attenuation of the elastic precursor. The principal role in shaping the front of the plastic wave is played by multiplication of dislocations. Figures 3, references 11: 6 Russian, 5 Western.  
[196-2415]

UDC 662.2:548.526

#### PROBLEMS IN THEORY OF DIFFUSION UNDER SHOCK WAVE

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 19, No 5, Sep-Oct 83  
pp 116-119

ZEMSKIY, S. V., KARPEL'YEV, V. A. and RYABCHIKOV, Dnepropetrovsk

[Abstract] No satisfactory theoretical explanation has yet been given for the "anomalously" large penetration of carbon into metals during action of a shock wave in various experiments. In this study a theory of diffusion is constructed, considering that a shock wave produces in a solid both reversible and irreversible strains with up to 95% of the work done on irreversible deformation converted into heat. This process is analyzed from the standpoint of thermodynamics, disregarding edge effects in a solid body such as a large thin metal plate. The equation of diffusive penetration  $\frac{\partial c}{\partial t} = D(x, T) \frac{\partial^2 c}{\partial x^2} + B(x, T) \frac{\partial c}{\partial x} + E(x, T)c$  ( $c$  - carbon concentration,  $t$  - time,  $x$  - depth coordinate,  $T$  - absolute temperature) is derived, assuming that the diffusion coefficient  $D$  obeys the Arrhenius law. The coefficients  $B(x, T)$  and  $E(x, T)$  account for the diffusion activation energy, the transport heat, and the force on impurity atoms in the crystal flaw field in the solid solution. With numerical data on the diffusion parameters and the process temperatures for alpha-iron and nickel, including the dimensionless number  $\tau = H^2 \alpha t$  ( $H$  - metal-to-air heat transfer coefficient,  $\alpha$  - thermal diffusivity,  $t$  - duration of shock wave) and the dimensionless depth coordinate  $z = x/\sqrt{\alpha t}$ , this equation has been solved for boundary conditions of the third kind for the transient period after the shock wave. A solution by numerical methods on a YeS-1022 Unified System digital computer has yielded the logarithm of the mean-integral diffusion coefficient as a function of  $\tau$  and the depth profile of carbon concentration in these two metals. Figures 2, references 4 Russian.  
[196-2415]

## PARAMETERS OF GEOMETRIC STABILITY OF LASER MIRROR OPTICAL SURFACE

Moscow POVERKHNOST': FIZIKA, KHIMIYA, MEKHANIKA in Russian No 11, Nov 83  
(manuscript received 13 Dec 82) pp 89-96

BOCHKOV, N. A., GORDEYEV, V. F., KOLESOV, V. S., KOSTIN, V. M. and  
IANIN, A. G.

[Abstract] Parameters of stability are determined for metal surfaces used in laser optics under conditions of thermal loading with cw and pulsed operation, included with consideration of effects that are determined by finiteness of the rates of propagation of heat and elastic deformation. For the purpose of determining the critical values of stress components of the stability parameters, an experimental investigation is made of the effect that plastic deformation has on coefficients of absorption and diffuse scattering. The strain with residual longitudinal extension of 0.01% is recommended as the limit of plastic deformation, and the corresponding stresses are determined for some materials. The resultant stability parameters are used in comparative analysis of materials from the standpoint of the outlook for using them in power metallic optics. The most promising materials are silicon carbide, tungsten and molybdenum, and for lasers with pulse duration shorter than 1 ms: 32NKD invar, tungsten and molybdenum. Figure 1, tables 2, references 10 Russian.  
[130-6610]

UDC 538.56

RADIATION OF OSCILLATOR WITH MODULATED AMPLITUDE MOVING IN DIELECTRIC MEDIUM

Tashkent IZVESTIYA AKADEMII NAUK UzSSR: SERIYA FIZIKO-MATEMATICHESKIKH NAUK in Russian No 6, Nov-Dec 83 (manuscript received 14 Jan 82) pp 39-43

DZHANGIRYAN, R. G., IVLIYEVA, I. N. and IL'IN, V. G., Department of Thermal Physics, UzSSR Academy of Sciences, All-Union Scientific Research Institute of Physicotechnical and Radiotechnical Measurements

[Abstract] The authors consider the problem of emission of a piecewise-continuous oscillator that oscillates for a specified time, and an oscillator with modulated amplitude, assuming that these oscillators move in an unbounded homogeneous dielectric medium with constant velocity along predetermined trajectories. The spectra of the emitted waves are found as a function of the velocity of the oscillators. Formulas are derived for loss of energy to radiation. References 5 Russian.  
[112-6610]

UDC 519.6:533.7

NOTE ON STABILITY OF NONLINEAR SCHEME FOR CALCULATING SHOCK WAVE MOTION

Moscow ZHURNAL VYCHISLITEL'NOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 23, No 5, Sep-Oct 83 (manuscript received 17 Nov 81, after revision 9 Jan 82) pp 1199-1204

MIKHAYLOV, Yu. A., Moscow

[Abstract] A conventional technique for linearizing nonlinear equations with subsequent local analysis of stability is used to show that the difference scheme used by S. K. Godunov for calculating the displacement of the boundary of a region (shock wave) is unstable in isolation. A simple scheme is proposed that does not have this flaw, and an examination is made of the problem of generalizing the algorithm to a greater number of variables. References 5 Russian.  
[143-6610]

## COMPARING METHODS OF SOLVING PROBLEM OF FIELD SCATTERING ON STEPPED WAVEGUIDE INHOMOGENEITY

Moscow ZHURNAL VYCHISLITEL'NOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 23, No 5, Sep-Oct 83 (manuscript received 3 Jun 81, after revision 3 Feb 82) pp 1257-1262

VOSKRESENSKIY, G. V., GALST'YAN, Ye. A. and ZHURAV, S. M., Moscow

[Abstract] Based on the example of the problem of diffraction of an electromagnetic wave by a shoulder in a circular waveguide, an analysis is made of various methods of solution utilizing field matching. It is shown that the problem can be reduced to two different infinite systems of algebraic equations. One of these is generated by the Jones method, the scattering matrix method and the method of regularization. The other system is produced by the method of matching and by the generalized method of matching. Organization of the computational process is simpler and faster for forming the matrix of the second system. Figures 2, tables 2, references 6 Russian. [143-6610]

## DIFFRACTION OF ELECTROMAGNETIC WAVE BY SCREEN OF ARBITRARY SHAPE

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 10, No 2, 26 Jan 84 (manuscript received 10 Nov 83) pp 68-72

SHIFRIN, K. S., SHIFRIN, Ya. S. and MIKULINSKIY, I. A., Institute of Oceanology imeni P. P. Shirshov, USSR Academy of Sciences

[Abstract] An analysis is made of the problem of diffraction of a plane homogeneous electromagnetic wave by a screen with arbitrary boundaries. Calculations are done in the Kirchhoff approximation for the case of normal incidence of the wave on the screen for the field in the Fraunhofer zone. A formula is derived for the average intensity of the diffracted radiation that is valid for arbitrary deviations of the screen outline from circular shape. The proposed formula can also be used to solve the inverse problem of synthesizing optical and radio devices that provide an assigned distribution of average intensity. Figure 1, references 3: 2 Russian, 1 Western. [124-6610]

## KINETICS OF GAS TRANSPORT-LIMITED GROWTH OF POROUS LAYERS

Leningrad PIS'MA V ZHURNAL TEKHNIЧЕСКОЙ FIZIKI in Russian Vol 10, No 1,  
12 Jan 84 pp 40-44

SOBOL', E. N.

[Abstract] Gas transport is typically a limiting factor for different processes of growing layers of different phase on the surface of a solid, e.g., by laser oxidation [A. M. Bonch-Bruyevich, M. N. Libenson IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA, Vol 46, 1982, p 1104]. Sobol' shows that accounting for a change in the mechanism of gas transport in porous layers leads to patterns of the transfer coefficient as dependent on temperature that are different from the findings of Bonch-Bruyevich and Libenson, enabling explanation of certain observed effects and prediction of some new modes of laser thermochemical reactions. The various mechanisms of gas transport in porous solids are analyzed on the basis of an ordinary diffusion equation, the processes of mass transfer being replaced by equivalent diffusion processes that take place in a tube of radius  $r = 2fH^{-1}$  (where  $f$  is the fraction of free cross section of pores in the overall surface of the solid, and  $H$  is the total surface of the pores in a unit of volume). The characteristics of the individual mechanisms, including the rate of molar transfer, are incorporated into the transfer coefficient as corresponding parameters. Figures 2, references 7 Russian.

[121-6610]

UDC 539.3

## PROPAGATION OF LONGITUDINAL ELASTIC WAVES IN MULTILAYERED HALF-SPACE

Baku IZVESTIYA AKADEMII NAUK AZERBAJDZHANSKOY SSR: SERIYA FIZIKO-TEKHNI-  
CHESKIKH I MATEMATICHESKIKH NAUK in Russian Vol 4, No 2, Oct-Dec 83  
(manuscript received 25 May 82) pp 43-48

RASULOV, M. B., Institute of Mathematics and Mechanics, AzSSR Academy  
of Sciences

[Abstract] The unsteady problem of one-dimensional longitudinal elastic wave propagation has already been solved for two-layer and three-layer media (I. G. Filippov, "Nestatsionarnyye kolebaniya lineynykh uprugikh i vyazkouprugikh sred" [Unsteady Oscillations of Linear Elastic and Viscoelastic Media], Tashkent, 1979; P. F. Sabodash, MEKHANIKA POLIMEROV, No 1, 1971). M. B. Rasulov now solves this problem for an arbitrary number of layers, revealing certain new mechanical effects. The model for analysis is an elastic isotropic medium filling the upper half-space and consisting of an arbitrary number of layers of different thicknesses with different properties. The medium lying on the surface of the half-space is in a state

of rest. At time-zero, a force that is a given function of time acts normally to the medium, with even distribution over the entire surface. The problem reduces to solution of wave equations with given initial and boundary conditions. An analysis is made of the field in each layer set up by multiple reflections of wavefronts from the interfaces between layers. The coordinates of points of maximum stress are determined, and it is shown that the greatest stress occurs in the middle of a half-wave layer with amplitude depending on the ratios of wave impedances. A graph of this result is given for a steel layer lying on an aluminum half-space. Figure 1, references 3 Russian.  
[161-6610]

UDC 539.375

#### WEDGE WITH CRACK IN BIELASTIC MEDIUM

Baku IZVESTIYA AKADEMII NAUK AZERBAYDZHANSKOY SSR: SERIYA FIZIKO-TEKHNICHESKIKH I MATEMATICHESKIKH NAUK in Russian Vol 4, No 2, Oct-Dec 83 (manuscript received 21 May 82) pp 53-58

GASANOV, Yu. N. and MEKHDIYEV, A. K., Institute of Mathematics and Mechanics, AzSSR Academy of Sciences

[Abstract] The Wiener-Hopf method is used to find an exact solution for the plane and antiplane problem of elasticity theory where a crack of finite length emanates from the vertex of a wedge with aperture angle greater than  $180^\circ$  in a bielastic medium made up of two isotropic elastic solids interfacing in a plane. The wedge is located entirely in one elastic medium, with the tip touching the interface. It is assumed that the faces of the wedge and the edges of the crack are free of external loads. The crack extends into the second elastic medium. The corresponding asymptotic behavior at infinity is given, and the coefficients of stress intensity are determined for a crack in normal rupture and longitudinal shear. References 6 Russian.  
[161-6610]

#### INVARIANCE OF EQUATIONS OF DIFFUSION THEORY OF FREE TURBULENT FLOWS

Ashkhabad IZVESTIYA AKADEMII NAUK TURKMENSKOY SSR: SERIYA FIZIKO-TEKHNICHESKIKH, KHIMICHESKIKH I GEOLOGICHESKIKH NAUK in Russian No 5, Sep-Oct 83 (manuscript received 30 Jun 83) pp 29-34

BAUM, V.A. and BAUM, I. V., Solntsa Scientific Production Association, TuSSR Academy of Sciences

[Abstract] Problems of phenomenological models of turbulent motion are considered, based on the example of Reichardt law. It is shown that



non-invariance of this law in its classical formulation relative to the group of galilean transformations is not fundamental. Invariant formulations of Reichardt law and other phenomenological models can be constructed by analysis of these models in conjunction with boundary conditions of dynamic problems in flow turbulence theory. References 13: 7 Russian, 6 Western.  
[116-6610]

UDC 523.035:535.36:539.125.523

ASYMPTOTIC FORMS OF EMISSION FIELDS IN OPTICALLY THICK SCATTERING MEDIA OF COMPLEX SHAPE

Minsk DOKLADY AKADEMII NAUK BSSR in Russian Vol 27, No 10, Oct 83  
(manuscript received 15 Dec 82) pp 901-903

ROGOVTSVO, N. N., Belorussian Polytechnical Institute

[Abstract] A scheme is proposed that uses an approach based on a general invariance principle for solving problems of transport theory in the case of scattering objects of arbitrary configuration. Some asymptotic expressions are obtained for the characteristics of emission fields in optically thick scattering media of complex shape. The analysis is based on general invariance relations derived by the author in previous papers [IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA, Vol 16, No 3, 1980, pp 244-253; ZHURNAL PRIKLADNOY SPEKTROSKOPII, Vol 34, No 2, 1981, pp 335-342; DOKLADY AKADEMII NAUK BSSR, Vol 25, No 5, 1981, pp 420-423; ZHURNAL PRIKLADNOY SPEKTROSKOPII, Vol 35, No 6, 1981, pp 1044-1050].  
References 15: 13 Russian, 2 Western.  
[105-6610]

UDC 538.11

RESTRUCTURING OF QUANTUM QUADRUPOLE ORDER IN MAGNETIC FIELD

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 25, No 12, Dec 83  
(manuscript received 12 Jul 83) pp 3655-3664

MATVEYEV, V. M.

[Abstract] The author considers a magnetic material described by an isotropic model with biquadratic exchange having quantum quadrupole order in the absence of a magnetic field. A variational principle is used with an adequate number of parameters for studying the ground state of such a system in a magnetic field. It is shown that in this case, magnetic susceptibility does not change with increasing field up to the critical level

where the structure begins to be ferromagnetic. A spin-wave approximation is constructed, taking this state as the base vacuum state. The magnon frequencies are positive, which is the basis of stability of the structure. References 8: 5 Russian, 3 Western.  
[151-6610]

UDC 534.23

NORMAL MODE METHOD OF SOLVING PROBLEM OF FORCED OSCILLATIONS OF RIB-  
REINFORCED SHELL OF REVOLUTION IN LIQUID

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 29, No 6, Nov-Dec 83  
(manuscript received 14 Jan 82, after revision 1 Dec 82) pp 744-748

VOROVICH, I. I., TSIONSKIY, A. Ya. and YUDIN, A. S., Scientific Research  
Institute of Mechanics and Applied Mathematics, Rostov State University

[Abstract] An analysis is made of steady-state low-amplitude forced oscillations of a shell of revolution with ribbed reinforcement in an ideally compressible unbounded fluid. It is assumed that the mechanical characteristics of the shell vary along the generatrix. The system of equations of the problem is written in dimensionless form for amplitudes, and expressions for circular modes are derived by Fourier trigonometric series representation of the solution. A method is given for reducing the problem to a system of linear algebraic equations relative to the coefficients of expansion of displacements only. This method has been programmed in FORTRAN for the BESM-6 computer. Examples are given showing application of the method to calculation of the pressure distribution in the plane perpendicular to the axis of shells of revolution in the midsection for different frequencies of the stimulating force. Figures 2, references 9: 8 Russian, 1 Western.  
[126-6610]

DYNAMICS OF BURNOUT OF SOLID FUEL IN FLUIDIZED BED OF FINELY DIVIDED INERT PARTICLES

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 19, No 5, Sep-Oct 84  
pp 60-62

BASKOKOV, A. P., MUNTS, V. A. and ASHIKHMIN, A. A., Sverdlovsk

[Abstract] Low-temperature combustion of coal in a fluidized bed was studied in an experiment where the change of coal mass could be measured, by weighing, as a function of time. A bed of finely divided corundum with particles of 120  $\mu\text{m}$  or 460  $\mu\text{m}$  size fractions had been fluidized with air in a retort containing a hollow cylinder with a welded-on grate. Specimens of coal of the 5-5.5 mm fraction from Irsha-Borodino, containing 43.7% C, 0.2% S, 13.5%  $\text{O}_2$ , 0.6%  $\text{N}_2$ , 3.0%  $\text{H}_2$  according to proximate analysis, were placed in this bed and heated to given temperatures within 350-900°C in amounts calculated for complete burning out within given lengths of time. The results of this study reveal an initially fast and then slower decrease of the coal mass with time, at rates which increase with higher temperature. The effective burnout intensity ( $\text{mg}/(\text{cm}^2 \cdot \text{s})$ ) increases almost linearly with increasing temperature, up to 400-500°C, and then remains constant as the temperature increases further even though the size of coal particles decreases. This, and the linear increase of the effective burnout intensity with increasing air velocity, indicates that the burnout rate is determined by diffusion of combustibles through the gaseous boundary layer rather than by the reaction kinetics. Such a hypothesis is not consistent with prevailing theory of mass transfer through fluidized beds and, therefore requires further verification. Figures 3, references 5: 3 Russian, 2 Western.  
[196-2415]

## SLAKING OF MODEL FUELS WITH ANOMALOUS PRESSURE DEPENDENCE OF COMBUSTION RATE

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 19, No 5, Sep-Oct 84  
pp 46-50

MARSHAKOV, V. N. and MELIK-GAYKOGOV, G. V., Moscow

[Abstract] Fuels such as nitroglycerin with a power-law pressure dependence of the combustion rate  $u \propto p^v$  are considered, particularly the slaking effect of additives such as lead and copper compounds. While normally, the combustion rate increases monotonically with increasing pressure ( $v > 0$ ), such additives cause it to become independent of the pressure ( $v \approx 0$ ) or even to begin to decrease with increasing pressure ( $v < 0$ ) at some pressure level. This interplay of combustion and slaking mechanisms was studied experimentally with three model fuels: nitroglycerin as standard and 2% of Cu-Pb compounds or 1% of Pb compounds added. The charges were wrapped in sheaths of polyvinyl chloride. After the trend of the pressure dependence of their combustion rate over the 0-150 atm range had been established by measurement and found to be nonmonotonic for both additives, the kinetics of pressure buildup and of the thermal boundary layer with temperature gradient at the combustion surface were measured during the transient period beginning with various initial pressures (100, 80, 40 atm). For an evaluation of the slaking effect, parameters of combustion waves characterizing each fuel had been determined from the steady-state temperature distribution on the basis of measurements with 3-5  $\mu\text{m}$  thick tungsten-rhenium II-thermocouples. The results reveal an anomaly at large falls from the initial pressure of 100 atm, the relaxation time for the thermal boundary layer being shorter than the critical time of pressure fall during which a change of mechanisms occurs. The authors thank A. P. Denisyuk for preparing the fuel specimens with additives and O. I. Leypunskiy, B. V. Novozhilov and A. A. Zenin for valuable discussion. Figures 4, tables 1, references 6: 5 Russian, 1 Western.  
[196-2415]

## COMBUSTION AND DETONATION OF HYDROGEN-AIR MIXTURE IN FREE SPACES

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 19, No 5, Sep-Oct 84  
pp 16-18

MAKEYEV, V. I., GOSTINTSEV, Yu. A., STROGONOV, V. V., BOKHON, Yu. A.,  
CHERNUSHKIN, Yu. N. and KULIKOV, V. N., Balashikha

[Abstract] An experimental study was made of combustion and subsequent detonation of hydrogen-air mixtures in free spaces. Such mixtures were held

in three thin rubber balloons (6, 35, 86 m<sup>3</sup>), with the hydrogen content in each varied over the 13-16% range (relative error not exceeding 2.5%). Combustion was triggered at the center, either weakly with a spark of 1 J energy in the two large balloons or strongly with 0.3-190 g charges of TNT in the small balloon. The transient buildup of flame radius and visible combustion rate were recorded, the combustion rate being also measured as a function of the hydrogen content in the mixture. It was found to be highest at 35% H<sub>2</sub> and to increase with increasing volume. The mass of explosive charge needed for detonation was found to first decrease sharply with increasing hydrogen content in the mixture, down to a minimum of only 1.86 g at 35% H<sub>2</sub>, and then slowly increase with further increase of the hydrogen content. The excess pressure in the shock wave was found to increase linearly with increasing energy density in the spherical wave. The results indicate that transition from combustion to detonation occurs in a small volume only after strong triggering, not after weak triggering. The results reveal also a similitude of energy characteristics in the three volumes. Figures 4, references 6: 5 Russian, 1 Western. [196-2415]

UDC 536.46

#### LIMITING EFFECTS DURING TURBULENT COMBUSTION

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 19, No 5, Sep-Oct 84 pp 7-9

KLIMOV, A. M. and LEBEDEV, V. N., Moscow

[Abstract] Transition from "surface" to "volume" combustion is considered, taking into account turbulization in the reaction zone with attendant line and surface expansion as well as limitations on the reaction rate. These limitations are established at the leading edge of the turbulent flame front and continue to apply during "surface" combustion. The equations of

steady expansion  $\frac{d^2\delta}{dx^2} + kx\frac{d\delta}{dx} + \phi = 0$  for a biplanar laminar flame with a plane layer of combustion products and  $\frac{d^2\delta}{dr^2} + (\frac{1}{r} + kr)\frac{d\delta}{dr} + \phi = 0$  for a hollow cylindrical laminar flame with combustion products inside have been solved numerically, with  $\phi = A_1(1 - \delta)^2e^{-2\delta/(1+\theta\delta)}$  corresponding to a thermal mechanism

and with  $\phi = A_2(1 - \delta)^2e^{-2\beta/(1 + \delta)}$  corresponding to a chain mechanism and reaction branchout with out break in the chain ( $\delta = (T - T_0)/T_F$ ,  $\theta = (T_F - T_0)/T_0$ ,  $\beta = E/RT_0$ ,  $R$  - gas constant,  $E = 18$  kcal/mole,  $T_0 = 300$  K initial gas temperature,  $T_F = 1024$  K adiabatic final gas temperature,  $T$  - instantaneous gas temperature during combustion,  $k$  - gradient of reaction rate). The results indicate only a slight difference between the two mechanisms.

They also indicate a significant role of these limiting effects in evolution of the flame core after spark ignition in a turbulent medium. Figures 2, references 5: 4 Russian, 1 Western.  
[196-2415]

UDC 536.46

# DIFFUSIVE COMBUSTION OF FLUIDS WITH FREE SURFACE

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 19, No 5, Sep-Oct 84  
pp 3-6

MIL'KOV, S. N., SUKHOV, G. S. and YARIN, L. P., Ukhta

[Abstract] Diffusive combustion of fluids with free surface is treated and analyzed as a complex process with interdependent kinetic and dynamic effects. Calculating the fundamental characteristics of this process, namely combustion rate and coordinates of the flame front as well as temperature and concentration profiles in the flame, involves solving the system of nonlinear differential equations of heat and mass transfer without a priori knowing the values of parameters at the free surface and at the flame front. Here the problem is solved first for a fluid burning inside a solid container of finite dimensions with attendant shifting of its free surface and then for a finitely thick layer of burning fluid on a solid surface or on an inert fluid half-space. The effective mass transfer coefficient and heat transfer coefficient are defined as

$$\bar{\alpha}_C = q_C / \Delta C = \frac{dG}{dx} \frac{1}{L_{fs}^2} \quad \text{and} \quad \bar{\alpha}_T = q_T \Delta T = c_p \bar{\alpha}_C \quad \text{respectively} \quad (G = \int_0^x \rho u dy, \text{ puydy,})$$

$\rho$  - density,  $x$  - longitudinal coordinate,  $u$  - longitudinal velocity,  $y$  - transverse coordinate,  $L_{fs}$  - characteristic dimension of free surface,  $q_C$  - mass flux,  $\Delta C$  - concentration difference,  $q_T$  - heat flux  $\Delta T$  - temperature difference,  $c_p$  - specific heat at constant pressure). Integration for boundary conditions corresponding to an infinitely high reaction rate yields a description of the steady-state combustion process. Integration for initial conditions corresponding to thermal equilibrium at the free surface yields a description of the transient combustion process.

References 3: 2 Russian, 1 Western.

[196-2415]

MATHEMATICS

UDC 517.958:537.812

REMARK REGARDING MONTE CARLO ALGORITHM FOR COMPUTING NONSTATIONARY LIGHT  
FIELD FROM DIRECTIONAL FORCE

Moscow ZHURNAL VYCHISLITEL'NOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian  
Vol 24, No 2, Feb 84 (manuscript received 4 Jan 82 revised 23 Jun 82)  
pp 314-316

ZAKHAROV, A. K.

[Abstract] A numerical example is employed to demonstrate that a previously published algorithm for computing the title light field can become inefficient when a back-scattering signal is being calculated, i.e., when the source and receiver are collocated or are separated by a distance smaller than the mean free path of a photon in the medium. A modified algorithm is proposed that eliminates this loss of efficiency. References 3 Russian. [187-6900]

STABILIZATION OF STATISTICAL SOLUTIONS OF SECOND-ORDER HYPERBOLIC EQUATIONS

Moscow USPEKHI METEMATICHESKIKH NAUK in Russian Vol 39, No 1 (235) Jan-Feb 84  
(manuscript received 4 Jul 83) pp 151-152

RATANOV, N. Ye

[Abstract] A strictly hyperbolic second-order operator  $L$  with infinitely smooth coefficients is posited. The Cauchy problem for the operator  $A$  is examined. In is necessary, inter alia, that the operator  $L$  satisfy the condition that the rays of the Cauchy problem approach infinity as  $t \rightarrow \infty$ . Two theorems are stated and proved. References 8 Russian. [185-6900]

## CODES AND INFORMATION

Moscow USPEKHI MATEMATICHESKIKH NAUK in Russian Vol 39, No 1 (235) Jan-Feb 84  
(manuscript received 14 Jan 83) pp 77-120

GOPPA, V. D.

[Abstract] This study reviews some of the results obtained in coding and information theory over the past 10 years, centering around reducing the Hamming problem to a Riemann problem, and the Shannon problem to the Hamming problem. The first chapter, on algebraic curves, provides a brief introduction to the theory of curves, with an accent on the computational aspect of this theory for a finite constant field. The second chapter, on error-correcting codes, introduces the basic concepts of coding theory and traces the path that this theory has covered during its movement to algebraic geometry. The third chapter, on information and symmetry, attempts to construct a theory of information after the model of physical theory based on symmetries and conservation laws. Information theory is treated as an abstract theory of words with their own specific coding-associated tasks. Each chapter incorporates a section containing historical and bibliographic information. References 56: 20 Russian, 36 Western.  
[185-6900]

## CONVERGENCE RATE OF CERTAIN DIFFERENTIATED AND CONJUGATE FOURIER INTEGRALS

Dushanbe DOKLADY AKADEMII NAUK TADZHIKSKOY SSR in Russian Vol 26, No 9,  
Sep 83 (manuscript received 27 May 83) pp 548-552

KOMOLITDINOV, D., Tajik State University imeni V. I. Lenin

[Abstract] The convergence rate of a differentiated Fourier integral and of the conjugate integral of a function  $F(x)$  in class  $W'D$  (with finite derivative at every point between  $-\infty$  and  $+\infty$ ) is determined on the basis of the integral analog of the Fatou theorem pertaining to uniform estimates on  $x$ . The function  $F(x)$  is one that satisfies two conditions: 1) there exists an interval  $[a, b]$  where  $F(x) = \int_0^x f(t) dt$ , with  $f(x)$  being a continuous function uniform on  $x$  such that  $\int_h^{h+\phi} [f(x+t) - f(x)] dt = O(|h|\phi h)$  and  $\phi(u)$  being a continuous increasing function such that  $\phi(0) = 0$  and  $\phi(u)/u$  does not increase; 2) it has a derivative  $F'(x)$  of bounded variation within any finite part of intervals  $(\infty, a)$  and  $(b, \infty)$ . This theorem is proved with the aid of two lemmas, one about an absolutely converging integral  $f(z) \int_0^\infty A(u, x) z^u du$  and one about the asymptotic behavior of singular integrals of an incompletely



conjugate function  $F'(x)$ . The theorem is proved completely, using a certain identity for and the analyticity of the integral  $\phi(z) = \int_0^\infty C(u,x)z^u du$ , where  $C(u,x)$  are complex Fourier coefficients of function  $F(x)$ . Article was presented by Academician A. D. Dzhurayev (TaSSR Academy of Sciences) on 3 April 1982. References 2 Russian.  
[163-2415]

UDC 519.852:517.956.225

# APPLICATION OF LINEAR PROGRAMMING TO NONLINEAR PROBLEMS WITH FREE BOUNDARIES FOR THE LAPLACE EQUATION

Moscow ZHURNAL VYCHISLITEL'NOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 23, No 5, Sep-Oct 83 (manuscript received 21 Jul 81) pp 1234-1238

AMROMIN, E. L. and BUSHKOVSKIY, V. A., Leningrad

[Abstract] A practical method is proposed for reducing a boundary value problem to a mathematical programming problem. Calculations involve a series of linear problems of mathematical physics and linear programming. A major advantage of the proposed method is that the volume of calculations is nearly independent of the number of undefined coefficients in the description of the boundary. The exposition is based on the problem of determining the shape of an axisymmetric supercavity, i.e., a problem in the theory of jets of ideal fluid that is known to have a unique solution that has already been determined by exact numerical methods. Figures 3, references 12: 9 Russian, 3 Western.  
[143-6610]

UDC 519.714.7

# PARTIAL DECIPHERING OF MONOTONIC BOOLEAN FUNCTIONS

Moscow ZHURNAL VYCHISLITEL'NOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 23, No 5, Sep-Oct 83 (manuscript received 12 Oct 81) pp 1267-1271

SOKOLOV, N. A., Moscow

[Abstract] Solutions in the Shannon formulation have long been known for the problem of complete decoding of a monotonic boolean function, and for the problem of finding the maximum upper zero. Here Sokolov considers the intermediate case: a solution is found in an analogous formulation for the problem of partial decoding of monotonic boolean functions, and the problem of finding the lexicographically greatest zero. It is shown that certain problems of integer programming are reducible to this problem, and the results are used to evaluate the complexity of solution of some problems of combinatoric optimization. References 5: 4 Russian, 1 Western.  
[143-6610]

# MINIMIZING LOSS PROBABILITY IN SYSTEM WITH TWO SERVERS OF DIFFERENT PRODUCTIVITY

Baku IZVESTIYA AKADEMII NAUK AZERBAYDZHANSKOY SSR: SERIYA FIZIKO-TEKHNICHESKIKH I MATEMATICHESKIKH NAUK in Russian Vol 4, No 2, Oct-Dec 83 (manuscript received 21 Jun 82) pp 130-135

SHAKHBAZOV, A. A., Institute of Cybernetics, AzSSR Academy of Sciences

[Abstract] A problem of optimum distribution of customer arrivals between servers in queuing theory is considered where a Poisson flow of customers of unit intensity arrives at the input of a system consisting of two servers of different productivity. The distribution functions of service time are given for each of the servers. Each customer may find both servers free, and in this event will occupy one of them in accordance with an assigned rule, or if one server is free, the customer will occupy that server, or in case both servers are busy, the customer will renege. The author constructs a rule of server occupancy that minimizes losses for the case where a customer finds both servers free. The proposed queue discipline is independent of service time distribution functions or intensity of arrivals, and depends only on the average service time.

References 7: 5 Russian, 2 Western.

[161-6610]

# SCHEDULING WITH MINIMUM WEIGHTED NUMBER OF DELAYED CUSTOMERS

Minsk VESTSI AKADEMII NAVUK BSSR: SERIYA FIZIKA-MATEMATYCHNYKH NAVUK in Russian No 6, Nov-Dec 83 (manuscript received 15 Apr 82) pp 3-8

TANAYEV, V. S. and GORDON, V. S., Institute of Technical Cybernetics, BSSR Academy of Sciences

[Abstract] A one-server n-customer scheduling problem is considered, assuming that customer arrival time coincides with the time when the server is unoccupied. The criterion functional is the weighted number of delayed customers. It is proved that an optimum schedule without pre-emption exists. A polynomial time algorithm is proposed for some special cases of the problem. References 9: 6 Russian, 3 Western.

[133-6610]

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